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## CHEMICAL AFFINITY.

IN the days of prescientific chemistry the term "chemical affinity" was used to indicate the cause of chemical transformations. It was self-explanatory. Simples united to form compounds because they bore a certain resemblance to each other, and it was known that "like draws to like," so that Becker explicitly put forward the proposition that two bodies capable of combination must contain a common principle. There the matter ended.

As science advanced it was seen that the primary meaning of chemical affinity had to be given up as an explanation, but the term itself was still retained to denote the cause of chemical phenomena, of whatever nature it might eventually prove to be. Attempts were made to identify this cause with one of the known natural forces. Newton and Berthollet, for example, were of opinion that chemical force was a manifestation of gravitational attraction. That it was a form of electrical attraction found supporters in Berzelius, Davy, Grotthus and Gmelin. Williamson attempted to reduce chemical action, as well as the phenomena of heat, light and electricity, to the perpetual movements of the ultimate particles of matter.

Finally, many chemists were content to describe chemical affinity as a "special force" not further characterised. Although this position amounts to giving up the problem for the meantime, it is that which so far corresponds best with our knowledge, or want of knowledge. At present

we are wholly ignorant of the cause of chemical change. All we can say is that it obeys the fundamental laws of energetics, and we know that as our knowledge of the special characteristics of chemical energy increases we shall be able to correlate it more closely with the other forms of energy, and thus in some measure arrive at an explanation of the occurrence of chemical phenomena.

A problem much better adapted to the state of science to-day is the investigation, not of the ultimate nature of chemical affinity, but of its magnitude. This problem was clearly before many chemists at the beginning of this century, and they arrived at ideas on the subject which are not yet out of date, and can bear repetition. Nicholson, in his *Dictionary of Chemistry* (1808), gives the following account of Berthollet's views (article, "Attraction"):—

"Mr. Berthollet has lately made a great number of experiments, from which he deduces the following anomaly: that in elective attractions the power exerted is not in the ratio of the affinity simply, but in a ratio compounded of the force of the affinity and the quantity of the agent; so that quantity may compensate for weaker affinity. Thus an acid which has a weaker affinity than another for a given base, if it be employed in a certain quantity, is capable of taking part of that base from the acid that has a stronger affinity for it; so that the base will be divided between them in the compound ratio of their affinity and their quantity. This division of one substance between two others, for which it has different affinities, always takes place, according to him, when three such are present under circumstances in which they can mutually act on each other. And hence it is that the force of affinity acts most powerfully when two substances first come into contact, and continues to decrease in power as either approaches the point of saturation. For the same reason it is so difficult to separate the last portions of any substance adhering to another. Hence, if the doctrine laid down by Mr. Berthollet be true to its utmost extent, it must be impossible ever to free a compound completely from any one of its constituent parts by the agency of elective attraction. . . .

"The solubility or insolubility of principles, at the temperature of any experiment, has likewise tended to mislead chemists of inferior accuracy, who have deduced consequences from the first effects of their experiments. It is evident that many separations may ensue without precipitation, because this circumstance does not take place unless the separated principle be insoluble or nearly so. The soda cannot be precipitated from a solution of sulphat of soda by the addition of potash, because of its great solubility; but, on the contrary, the new compound itself, or sulphat of potash, which is much less soluble, may fall down, if there be not enough water present to suspend it. No certain knowledge can therefore be derived from the appearance or the want of precipitation, unless the products be carefully examined."

The preceding paragraphs might almost have been copied from the latest modern text-book, and the errors against which the author warns his contemporaries still continue to mislead "chemists of inferior accuracy". The principle involved in the distribution of a base between two acids, *i.e.*, the general principle of balanced action, affords, as we shall see, one of the best means of determining the relative affinity of the competing substances.

Some thirty or forty years ago great hopes were entertained that thermochemistry, as then understood, would furnish us with a true measure of chemical affinity. The energy lost or gained in a chemical reaction can easily be measured in terms of heat, and the determination of these heats of reaction formed almost the sole problem of thermochemistry until within quite recent years. It was thought that the chemical force or affinity causing the action must in some way be proportional to the thermal effect of the action. But this is merely a recrudescence of the old dog-Latin fallacy *causa æquat effectum*, and has no theoretical foundation. Berthelot gave expression to this idea in his principle of maximum work, which states that in a chemical change those substances are produced whose formation occasions the greatest development of heat. Although there is no doubt that this principle roughly represents the facts when

actions taking place at low temperatures are alone considered, there are so many exceptions to the rule that no general validity can be claimed for it. The chief reason for the comparative want of success of thermochemistry in the development of chemical theory is to be found in its exclusive adherence to the first law of thermodynamics, the second being altogether neglected. Of late years, however, this has been largely remedied, so that we are now in a better position to judge of the relation of heat to chemical energy.

The rate at which a chemical reaction takes place has also been proposed as a measure of the forces at work in producing the action, but this also is unsatisfactory. Sodium and chlorine are generally supposed to have a powerful affinity for each other, but if both are dry they will not unite at the ordinary temperature. Sodium when added to alcohol under ordinary conditions acts on it most vigorously, especially if the alcohol contain water. Pictet, however, has shown that at $-80^{\circ}$ sodium is without action on aqueous alcohol. The actions then in these cases must go on with such extreme slowness as to be imperceptible, yet we attribute to the reacting substances considerable chemical attraction for each other.

There is, as has been said above, one class of chemical reactions which is of great service in indicating the direction in which we are to seek for an explanation of chemical affinity, which affords us a practical measure of relative affinities, and which indicates the relation of these both to velocities of reaction and to energy in general; the class, namely, of balanced actions, and it is such an action that Berthollet has under consideration when he speaks of a base being divided between two acids possessing different affinities for it. We have each of the acids acting on the salt of the other acid at a certain rate, and the point where the one action balances the other is determined by the velocities of the opposed reactions, and by the quantities of the reacting substances. Guldberg and Waage showed experimentally that the action of each substance is proportional to its active mass, *i.e.*, to its amount divided by

the volume in which it is contained, and this enables us to give an exact expression for a balanced action of any type.

Suppose that we have two acids A and $A^1$, with their salts S and $S^1$, and that A and $S^1$ are dissolved in such a quantity of water that their active masses are each represented by 1. Then, at the beginning of the action, we have the two interacting to form the other pair $A^1$ and S, the chemical equation being $A + S^1 = A^1 + S$.

After equilibrium has been reached, *i.e.*, when the two opposed reactions are balanced so that in a given time just as much of the pair A, $S^1$ disappears as is produced in the same time by the interaction of the pair $A^1$, S, a certain amount $\chi$ of the original salt and acid will have been transformed, so that their active masses are now no longer 1, but $1 - \chi$. The rate at which these pass into the other acid and base is proportional to the active mass of each, so that we have—

$$\text{rate A, } S^1 \rightarrow A^1, S = k\,(1 - \chi)\,(1 - \chi),$$

where $k$ is a constant, expressing the amount of the reaction in unit time when the concentration of each of the reacting substances is unity. Now the active masses of the second acid and base are $\chi$ and $\chi$ respectively, for just as much of each of them has been formed as there has disappeared of the others. We have therefore—

$$\text{rate } A^1, S \rightarrow A, S^1 = k^1\,\chi\cdot\chi,$$

where $k^1$ is the velocity constant of the second reaction. But the amounts transformed in unit time are equal at the point of equilibrium, so that we have—

$$k\,(1 - \chi)^2 = k^1\,\chi^2,$$

$$\text{or } K = \frac{k}{k^1} = \frac{\chi^2}{(1 - \chi)^2}.$$

It is therefore easy from a determination of the amounts of the various substances present at the point of equilibrium to ascertain K the ratio of the velocity constants of the opposed reactions. Julius Thomsen employed a thermochemical method for determining the extent to which the action of one acid on the salt of another had taken place.

It could be calculated from known data how much heat would be given out or absorbed when the equivalent of the first acid replaced the equivalent of the second from its salt. On actually performing the experiment the thermal effect was always found to be less than that calculated for total replacement. The ratio then of the observed to the calculated heat gave the extent to which the action had progressed. Methods similar in principle were afterwards employed for ascertaining such ratios of distribution, *e.g.*, the change of volume, and the change of the refractive index on reaction, were measured by Ostwald instead of the heat-change. When the ratios obtained by balancing a series of acids against the salt of one other acid were tabulated, a set of numbers resulted which were called by Thomsen the "avidities" of the acids. These avidities were proportional to the square root of the velocity constant K. Now the constant K has an important theoretical significance, inasmuch as the maximum work to be obtained from a reversible chemical change isothermally conducted is equal to $RT \log_e K$, where R is a numerical constant, and T the temperature on the absolute scale at which the equilibrium occurs. This maximum external work is the difference of the "free energy" of the two systems, if we employ the term in the sense proposed by Helmholtz, and is not proportional to the change of total energy of the two systems, *i.e.*, to the thermal effect of the reaction. As every spontaneous natural process takes place in the direction in which external work is performed, the total amount of external work which a system can perform must have a close connection with the internal forces (in our case "chemical affinities") causing the change. Thus it has been proposed to take the change of "free energy" as a measure of the affinity instead of the change of total energy adopted by the earlier thermochemists.

Little has been done as yet towards calculating affinity constants on this basis, and chemists are at present content with more empirical magnitudes. The relative affinities of the acids in particular have been well investigated from very many different points of view, and the results obtained

by the various methods show excellent agreement with each other.

A method which has been found well suited for the comparison of the stronger acids with one another is found in estimating the rate at which they accelerate chemical processes. For example, cane-sugar solution will remain at the ordinary temperature for an indefinite period without showing any tendency to pass into a mixture of dextrose and lævulose, but if an acid be present the inversion of the sugar begins immediately, and goes on until the cane sugar is completely transformed. It was found that the rate of inversion with a given acid is very nearly proportional to the concentration of the acid used; but that for equivalent quantities of different acids, the rate varies greatly. If the acids are arranged in the order in which they accelerate the inversion of cane sugar, it is found that this order is identical with that obtained when the acids are arranged according to their "avidities" as determined by an equilibrium method. Other acceleration processes have now been studied, and all agree in giving the acids in the same order as they appear in the inversion of cane sugar, which order is identical with that obtained when the acids are arranged according to the electrical conductivity of their equivalent aqueous solutions. There is no obvious connection between these two properties of acids, *viz.*, their chemical reactivity, and their power to conduct electricity, but an explanation is found in the electrolytic dissociation theory of Arrhenius. His theory refers both properties to the same cause—to the amount of dissociation of the acids into the positive ion hydrogen, and the negative ion of the acid. Acids are chemically active in the measure that they produce hydrogen ions, which alone determine the specific acid character. These hydrogen ions are also the chief carriers of electricity in an acid solution, so that the more of them an acid can produce when dissolved in a certain quantity of water, the more active will it be chemically and the better will it conduct electricity. The degree of dissociation then of an acid is an excellent measure of its strength. By applying the law of gaseous dissociation to

this case of dissociation in solution, Ostwald has been able to calculate a constant from the conductivities of the weaker acids at different dilutions, which he regards as a good expression of the affinity of the acid. The dissociation constant, or affinity constant, determined in this way is independent of the amount of water in which the acid is dissolved.

For bases we have methods corresponding to those employed for acids. First of all we have one acceleration process—the conversion of hyoscyamine into the isomeric alkaloid atropine. Under the influence of strong bases this transformation occurs at a rate depending on the strength of the base, other things being equal. Then we have a class of reactions in which the base participates directly, namely the saponification of ethereal salts. The rate at which ethyl acetate, for example, is converted by a base into the acetate of that base and ethyl alcohol is a measure of the strength of the base. Again, it is found that the electrical conductivity of aqueous solutions of the various bases is proportioned to their strength as determined by any of the above methods. The explanation given by the theory of electrolytic dissociation is that the specific activity of bases is due to the hydroxyl ions which they produce when dissolved in water, and that the strengths of the bases, together with their electric conductivities, are closely proportional to the number of these ions produced when the bases are in equivalent solution. A dissociation or affinity constant for bases can also be calculated in a manner precisely similar to that adopted for the dissociation constants of acids.

The proximate problem of chemical affinity then is to determine as many of these characteristic dissociation constants for acids and bases as possible, for they can be used in solving very many problems of the speed of reactions and the equilibrium of opposed reactions in aqueous solutions, with which the chemist is mostly concerned.

The methods detailed above are well suited for the investigation of all but the weakest acids and bases, but

there they fail entirely, and we have to resort to equilibrium methods for ascertaining the affinities of those substances. There is one substance which is very convenient as a standard of comparison against which to compare the strengths of both weak acids and weak bases, namely, water. Weak bases give off comparatively few hydroxyl ions OH, and weak acids few hydrogen ions H. Now water in the pure state dissociates electrolytically to a minute extent into these ions, $H_2O = H + OH$, so that it can act both as a very weak acid and a very weak base, according as it competes against another acid or another base. The amount of the dissociation of water is extremely slight, a calculation by Kohlrausch showing that a cubic meter, *i.e.*, about a ton, of water at 18° C. contains only 1·64 milligrams dissociated into hydrogen and hydroxyl ions.

A base like diphenylamine is so weak that, although it can form a hydrochloride, the salt, when treated with water, has the hydrochloric acid washed entirely away, leaving the free base behind. Here the water plays the part of a base against the diphenylamine, and competes with it for the hydrochloric acid. Aniline is a much stronger base than diphenylamine, but still its hydrochloride, when dissolved in water, is split up partially into aniline and hydrochloric acid. By comparing the amounts of free hydrochloric acid obtained from equivalent solutions of the hydrochlorides, we can ascertain the relative strengths of the bases, for the stronger the base is the less will its salt be decomposed by a given quantity of water. The amount of free hydrochloric acid in the solutions cannot be estimated by any ordinary analytical process, but can be determined indirectly by ascertaining, for example, how rapidly the solution inverts cane sugar, the rate depending on the amount of free acid present.

Similarly salts of weak acids may be decomposed by water. The cleansing properties of washing soda and of soap depend on the fact that these are sodium salts, whose acids are so weak that there is partial, though slight, decomposition into the acid and free caustic soda when the salts are dissolved in water. The amount of soda present

may be calculated from the rate at which the solution saponifies ethyl acetate.

These equilibrium methods have now put us in a position to give the order of affinity of both acids and bases from the strongest to the weakest, and even for the weakest an approximation to the dissociation constant can be calculated.

With regard to other affinities, the study of electromotive force seems to promise excellent results in certain directions, but the solution of the general problem is still the task of the future.

JAMES WALKER.

# VIEWS ON MINERAL SPECIES.

THE death of James Dwight Dana, following only three years after the publication of the sixth edition of his great "*System of Mineralogy*," calls to mind the remarkable changes which have transformed mineralogical science since the appearance of the first edition of that work in 1837.

It is my purpose in the present article to call attention only to the change of views regarding classification and nomenclature which has occurred during the intervening period, and to criticise the position in which mineralogists now stand in the matter of mineral species, their definition, and their relationships.

Professor J. D. Dana was attracted to the study of mineralogy early in life, and died at the age of eighty-two; he was always the most prominent systematist in this science, and from his intimate acquaintance with geology and zoology was singularly fitted to hold wide and comprehensive views upon such subjects as the definition and systematic arrangement of species; he reformed the nomenclature of mineralogy, and constructed a system from the ruins of its unsuccessful predecessors which had prevailed in the early part of the century; consequently his book in its various editions may almost be regarded as an authoritative record of the successive steps taken by Systematic Mineralogy during more than half a century, and reflects the varying aspects which that ever-shifting subject has presented at different times. The sixth edition, though largely rewritten by his distinguished son, is carried out strictly on the lines laid down in the preceding editions.

## THE NATURAL HISTORICAL SYSTEM OF CLASSIFICATION.

It is difficult now to believe that in the first and second editions the author warmly espoused the so-called Natural System of Werner and Mohs. According to that system, the only characters of minerals which possess any importance for purposes of classification are the external

characters: the specific gravity, crystalline form, hardness, lustre, colour, and frangibility. The chemical composition was regarded as of absolutely no account, although Berzelius had as far back as 1815 proposed a purely chemical classification of minerals. Jameson indeed claimed for the Wernerian system that it was totally independent of any aid from chemistry.

One great inconvenience which resulted from the adoption of these principles at so early a date was the enormous complication in nomenclature. Mineralogy has suffered in this respect in two ways. Until a recent date the want of a satisfactory system has often rendered it difficult to refer a new specimen to a known species, and has enabled mineralogists to gratify their vanity as discoverers by giving a new name. The result is that at the present time there must be at least 8000 mineral names, including synonyms, although not more than 800 mineral species are recognised as well established. In the second place, while the Natural System was predominant, many authors introduced a new nomenclature of genera, species and sub-species to indicate the natural relationships between the various minerals.

Thus Dana himself, in his first edition, invented a Latin nomenclature for the system of Mohs with this object, "constructed on the plan so advantageously pursued in botany and zoology".

Take, for example, the three well-established groups of minerals known as Garnet, Felspar, and Scapolite. The minerals now included under those three names respectively are so closely allied in all their characters, external as well as chemical, that they form three natural groups which it would be difficult to sub-divide in any mineralogical classification.

In the system of Mohs (1825) they were thus arranged:—

| Species. | Genus. | Order. |
|---|---|---|
| Garnet | Garnet | Gem |
| Feldspar | Feldspar | Spar |
| Scapolite | Feldspar | Spar |

In the system of Dana (1844):—

| Species. | Genus. | Order. |
|---|---|---|
| Garnet | Carbunculus | Hyalinea |
| Felspar | Spatum | Chalicinea |
| Scapolite | Scapolus | Chalicinea |

The order Gem of Mohs, with which the order Chalicinea of Dana is almost identical, is defined as comprising non-metallic minerals having a non-adamantine lustre, and an uncoloured powder (streak), with a hardness between $5\frac{1}{2}$ and 10, and specific gravity between 1·9 and 4·7.

The genus Garnet of Mohs is defined as comprising minerals with a lustre which is not purely vitreous, having a hardness between 6 and 7, and a specific gravity between 3·1 and 4·3. It includes, in addition to Garnet, the minerals Idocrase, Helvine, and Staurolite.

The genus Spatum of Dana comprises minerals having a hardness between 4 and $6\frac{1}{2}$, and a specific gravity between 2·1 and 2·8. It includes, in addition to Garnet, the minerals Idocrase, Helvine, Staurolite, and Epidote.

Epidote in the system of Mohs was a species referred, together with Pyroxene and Amphibole, to the genus Augite-spar, defined as possessing a non-metallic pearly lustre, with hardness $4\frac{1}{2}$ to 7, and specific gravity 2·7 to 3·5.

When we remember that a hardness $4\frac{1}{2}$ merely signifies that the mineral will scratch Fluor and is itself scratched by Apatite, and that the specific gravity of garnet may vary from 3 to 4, it is evident that these characters are ill suited to define a species even for purposes of practical determination.

### THE CHEMICAL SYSTEM.

At this period the battle was raging furiously between those who supported the Natural, or as Mohs called it, the Natural-historical System, and the adherents of the chemical system of Berzelius. A compromise was ultimately effected by the system, due largely to the independent labours of Rose and Rammelsberg, which considers the crystalline form and the chemical composition as conjointly necessary and sufficient to define a species. This mode of regarding minerals is almost universally

accepted at the present day as the basis of any scientific scheme of classification, and with its introduction the older views have almost entirely passed into oblivion.

Here again Dana's mineralogy accurately represents the progress of events. Rose's Krystallo-chemisches System, which is generally taken as the starting point of the newer methods, was published in 1852; but already in his third edition (1850) Dana, who was always ready to grasp after right methods and to sacrifice personal predilection, had dropped the old system entirely. In the preface to that edition the following remarkable words occur: "To change is always seeming fickleness. But not to change with the advance of science is worse; it is persistence in error; and, therefore, notwithstanding the former adoption of what has been called the Natural History System and the pledge to its support given by the author in supplying it with a Latin nomenclature, the whole system, its classes, orders, genera, and Latin names have been rejected, and even the trace of it which the synonymy might perhaps rightly bear has been discarded."

Principles similar to those which guided Rose had been previously laid down by Hausmann and Fuchs, but were less completely elaborated. Rose himself had been clearing the way towards this end for twenty years; but the third edition of Dana's System set the seal upon the new departure, and from that date modern views upon mineral species may be regarded as firmly established. We hear little more of orders and genera; minerals which are closely allied are brought together into groups; those which deviate only slightly and in unimportant respects from a normal type retain their trivial names, but are only regarded as "varieties"; and, finally, all the different minerals and mineral groups, which for the most part show very slight resemblances one to another, are classified in a somewhat disjointed manner by their chemical composition, the purely chemical arrangement being only so far modified as to bring together those which are "isomorphous," *i.e.*, which with analogous composition exhibit also a close similarity of form.

## MODERN NATURAL HISTORICAL SYSTEMS.

To revive recollections of the old Natural History System at the close of the century may seem to be an unprofitable exhumation of buried feuds, but there are two reasons why it should be far from superfluous. In the first place the system is not really dead, and it expresses certain truths and relations which are in themselves permanent; in the second place a reaction against the classification of Rose, that is to say, against a chemical classification as commonly understood, has been in progress for some years, and the tendency of the present changes and of the future developments, of which they are the precursors, can best be read in the light of this past history.

Mohs, who succeeded Werner at Freiberg, was himself succeeded by Breithaupt, who retained all the traditions of the Natural History School of Mineralogy in this great centre of mining industry and education; and his successor, the present occupant of the chair, Dr. Albin Weisbach, has never forsaken the system.

The *Synopsis Mineralogica* of Weisbach (1884) divides minerals into four classes: hydrolyte or soluble compounds, lithe or stones, metallolithe, metallite or ores, and causte or inflammable compounds. The three minerals chosen above for examples belong to the second of these classes which is divided into three orders: Kuphoxyde or oxides, Pyritite or silicates, and Apyritite or non-silicates.

The order Pyritite is subdivided into four families: Sklerite, Zeolite, Phyllite and Amorphite; Garnet, Felspar and Scapolite belong to the first of these families, in which the various mineral species are arranged according to their crystallographic systems.

Possibly few English mineralogists are aware that this antiquated type of classification is still in vogue; its adoption at the great mining centre invests this system with a stamp of authority in spite of any objections which may be urged against it from a purely scientific point of view. A classification which, for example, not only separates Apatite from Pyromorphite, and Chalybite from Calcite, but even

places these minerals in different *classes*, is certainly not in harmony with modern ideas.

At Freiberg no doubt the characters of minerals are studied almost entirely with a view to their practical determination; this was certainly to a large extent also the consideration which influenced the School of Mohs in relegating the chemical characters to a secondary place; for a chemical analysis is rarely either possible or convenient if a mineral may be recognised by other means, while the external characters are mostly a matter of easy observation. Hence it is natural that among practical mining students and those to whom the determination of minerals is the end and object of Mineralogy, the methods, and therefore also the classifications of the Wernerian School, have continued to find favour.

But an even more serious attempt to raise the Natural System to the rank of a scientific principle has recently been made.

Thomas Sterry Hunt was always an original and suggestive writer on mineralogical and geological subjects on their more philosophical side, and shortly before his death he published a book entitled *Systematic Mineralogy based upon a Natural Classification* (1891). Brought up in the traditions of the Natural History System under C. v. Shepard, who was its exponent in America, Sterry Hunt endeavoured to effect a reconciliation between the Natural and the Chemical Systems by developing the former so as to include by implication the latter, and thus to "form a new system of classification which will be at the same time chemical and natural-historical".

This extremely curious, and in part fantastic, volume merits somewhat closer attention. The author starts with the conviction, shared probably by most of his readers, that the physical characters of any chemical compound and its composition are dependent each on the other, "and present two aspects of the same problem which can never be solved but by the consideration of both". Hence the specific gravity and the hardness, so prominently used in the old systems, must give a clue to the chemical composition, and

if correctly interpreted should lead to the same classification as the latter.

Dr. Sterry Hunt next supposed that the specific gravity of any substance, whether gaseous, liquid, or solid, is its molecular weight, and hence that the degree of condensation of any species can be determined from its specific gravity referred to hydrogen gas as unity; on this hypothesis the degree of condensation is the reciprocal of the atomic volume $v$, and $v = \frac{p}{d}$ where $p$ is the equivalent weight and $d$ the specific gravity.

With these assumptions water is about 1192 $H_2O$, and the co-efficient of condensation is 21400; calcite is 584 $Ca\,CO_3$, quartz is 950 $Si\,O_2$.

It is next asserted that the hardness of a species varies inversely as the atomic volume, and that the solubility increases with the atomic volume.

According to this view minerals and the other solid chemical compounds are highly polymerised substances, of which the degree of polymerisation can be determined from the specific gravity and is also indicated by the hardness and solubility. The Mineral Kingdom is thus divided into four classes, Metallaceæ, Halidaceæ, Oxydaceæ, Pyricaustaceæ, which are again sub-divided into orders, genera, and species. The orders are based upon chemical composition alone; thus the Oxydaceæ, or oxygen compounds, are divided into twenty-two orders, of which Oxidinea, Boratinea, Spinellinea, Carboninea, Silicinea, and Argillinea (more commonly known as Oxides, Borates, Aluminates, Carbonates, Silicates, and Alumo-silicates) are the first six.

The genera are based upon "natural-historical characters," *i.e.*, lustre, hardness, and atomic volume; thus in the order Argillinea, Felspar (together with Petalite and Cordierite) constitutes the genus Agrolithus, which is spathoid (*i.e.*, sparry) in appearance, with hardness less than 7, and atomic volume greater than 6; Garnet constitutes the genus Granatus, which is adamantoid (*i.e.*, gemmy in appearance and not easily soluble), with hardness greater

than 6 and atomic volume less than 6. Each species receives a Latin name; *e.g.*, among the Garnets are Granatus Almandicus, Granatus Manganosus, etc.

The chemical relations of the various species are further supposed to be similar to those of the carbon compounds; what is commonly known as an isomorphous group of minerals is therefore to be regarded as a homologous series differing by multiples of a certain radicle; if in two or more minerals having a similar empirical composition the value of $v$ is the same they may be regarded as having a metameric relationship; if the value of $v$ differs they are isomeric homologues which are differently polymerised. In a previous essay it had, for example, been suggested that Calcite has the formula $C_{30}\ Ca_{30}\ O_{90}$ and Calamine $C_{40}\ Zn_{40}\ O_{40}$.

This is not the place to enter further into these questions or to discuss the new mode of chemical notation introduced by Sterry Hunt in conformity with his views; our present purpose is to compare this and the other natural systems with the orthodox classification of the present day.

It may be noted, however, in passing that the principle of polymerisation is introduced in a still more comprehensive manner by Goldschmidt, who, in 1890, proposed to consider all silicates as polymers of $Si\ O_2$ in which a portion of the silicon is replaced by other elements whose combined valency is the same. In this scheme all silicates belong to the type $n\ Si\ O_2 + p\ H$ where H is water or such a radicle as KF; thus Orthoclase is $(Si\ O_2)_4$ in which one atom of Si is replaced by the radicle $K_2\ Al$; the Garnet $Ca_3\ Al_2\ Si_3\ O_{12}$ is $2\ (Si\ O_2)_3$ in which one atom of Si is replaced by $Ca_2$ and two atoms of Si by Ca Al.

Other systems of mineral classification, such as that adopted by De Lapparent in his admirable *Cours de Minéralogie*, which arrange the species not by their characters but by their origin and mode of occurrence in nature, we may pass by as not scientific systems, whatever may be their educational value or convenience; since, if anything is certain, it is that the essential characters and

the composition of a mineral, and their mutual relations, are constant, though the mineral may be produced in nature or artificially in a thousand different ways.

DANA'S SYSTEM.

The very existence, however, of the systems discussed above, and they are only a few out of many, if it signifies anything, surely indicates a state of unrest, a feeling of dissatisfaction with the orthodox views, if there be such. We must then proceed to consider the general principle at present current among mineralogists as embodied in the last edition of Dana's *Mineralogy*, and the manner in which it has won acceptance since the date of the third edition (1850), when the Natural System was abandoned.

In that volume minerals were grouped together as (1) Elements, (2) Haloids, (3) Silicates, Aluminates, etc., (4) Metals and metallic ores; the minerals in each group being arranged according to their metal. This plan, of course, again separated such minerals as Apatite and Pyromorphite, which are closely allied, and was destined to be replaced by some arrangement in which the compounds of each metal are not classed together but are distributed into groups according to their natural affinities.

The present edition classes minerals roughly as follows:—

I. Elements.
II. Sulphides (tellurides, etc.) (*a*) of semi-metals.
(*b*) of metals.
III. Sulpho-salts.
IV. Haloids.
V. Oxides:—(*a*) of silicon.
(*b*) of semi-metals.
(*c*) of metals.
VI. Oxygen salts:—(1) Carbonates, (*a*) anhydrous, (*b*) acid, basic, and hydrous.
(2) Silicates (and titanates), (*a*) anhydrous (*b*) hydrous.
(3) Niobates, etc.
(4)]Phosphates, arsenates, etc.
(5) Borates.
(6) Sulphates, etc., (*a*) anhydrous, (*b*) acid, basic, and hydrous.
(7) Tungstates, etc.
VII. Organic compounds.

Under this scheme, which closely resembles that of Rose, the so-called isomorphous groups are successfully retained undivided.

A great merit of Dana's fourth and succeeding editions was that minerals which have been proved to be the same, or only to differ in unimportant particulars, such as a slight variation of some constituents, are brought together under one name. No new name is invented, but in accordance with the law of priority, one of the names previously used is applied to the mineral as a species, while the others are retained either as the names of varieties or as synonyms; they can never be eradicated from the literature, and hence it is important to keep them in their proper place.

This excellent plan, though it apparently deprives Mineralogy of system, or at any rate of systematic nomenclature, and preserves only trivial names which are often uncouth or absurd, is really the only plan which can be satisfactorily adopted at the present time. It possesses the necessary elasticity which enables us to transfer a given mineral from one species to another if it be proved to be more closely related to the latter.

The principles of classification are comparatively easy so soon as the method of Dana and Rose is accepted; every mineral specimen is supposed to possess a definite chemical composition and a definite crystalline form; those which resemble one another both in composition and form are brought together into a "group". Thus the rhombohedral carbonates $Ca\,CO_3$, $Mg\,CO_3$, $Zn\,CO_3$, $Mn\,CO_3$, $Fe\,CO_3$ are five minerals similar in composition and in crystalline form, and they are brought together in the system into one group; so also are the four garnets $Ca_3\,Al_2\,(Si\,O_4)_3$, $Ca_3\,Cr_2\,(Si\,O_4)_3$, $Ca_3\,Fe_2\,(Si\,O_4)_3$, $Fe_3\,Al_2\,(Si\,O_4)_3$.

In reality the scheme is not so easy of application for two reasons: (1) because minerals are never so perfectly simple in composition but graduate into one another, so that it is difficult to say where a given species begins and where it ends; (2) because the groups are so few in number, and there are hundreds of minerals which have to remain

as isolated species if the system be rigidly adhered to, since they cannot be referred to any known group.

Above all the chief difficulty remains with the silicates, of which the anhydrous section is by Dana sub-divided into bi-silicates, meta-silicates, ortho-silicates and sub-silicates, according to the ratio of the oxygen of the silica to that of the bases. In reality it is extremely difficult to say what is to be regarded as acid and what as base; in the hydrous section this is not even attempted, but the minerals are classed under Zeolites, Mica Division, Serpentine Division, Kaolin Division, etc.

Now in these cases we clearly have a partial retention of the old Natural method; for the Micas, Chlorites, etc., are practically grouped by their physical characters, the composition being too hopelessly complex to serve as the sole basis of classification; if a mineral is obviously allied to the Micas it remains with them although the formula cannot be brought into exact harmony with that of any Mica.

This is only one instance among many which might raise in the mind of an unbiassed reader the suspicion that after all our system is to a certain extent designed to bring together minerals which are declared by their external characters to be allied and would therefore have been classed together under the old Natural Classification; and when the system does not harmonise with the natural grouping it is the former which must give place to the latter.

The Zeolites, the Micas, and the Chlorites are natural groups like the Felspars or the Pyroxenes, although their affinities cannot yet be fully explained like those of the Garnets or of the Calcite group by a simple relation of isomorphism.

## MINERAL SPECIES.

The success, however, which has attended the present system in some of the better-defined groups, such as the Garnets, has led to a conviction that all minerals will ultimately be regarded as either simple compounds or as isomorphous mixtures of simple compounds; the five Garnets mentioned above may be distinguished under the

names Grossular, Uvarovite, Melanite, and Almandine. None of them exist in nature as absolutely pure compounds, but only as substances which can be regarded as mixtures of these five compounds with one another and with such compounds as $Mg_3\ Al_2\ (Si\ O_4)_3$ and $Mn_3\ Al_2\ (Si\ O_4)_3$, magnesia—and manganese—garnets which are more or less hypothetical; the name applied to a given specimen being that of the simple compound to which it most closely approximates.

Now there are here two possibilities to be distinguished. Two compounds A and B are related in form and composition. If they are isomorphous in the strict sense of the term, they are also capable of crystallising together in indefinite proportions to make an intermediate compound $m$A + $n$B where $m$ and $n$ are any numbers; if they are not strictly isomorphous they may crystallise together to form a compound $m$A + $n$B where $m$ and $n$ are simple whole numbers, and this is not infrequently similar in form to the components. Further, both A and B may exist as minerals, or A may be a known mineral and B an artificial compound, or A may be a known mineral and B a compound whose existence is only inferred from that of the intermediate compounds $m$A + $n$B, or, as the last extreme, both A and B may be only hypothetical compounds introduced to explain the composition of the minerals $m$A + $n$B.

Thus, for example, in the carbonate series mentioned above it is not yet known whether Dolomite is an isomorphous mixture of Magnesite $Mg\ CO_3$ with Calcite $Ca\ CO_3$, or a definite compound $Mg\ Ca\ (CO_3)_2$, or a mixture of this double salt with Magnesite and Calcite. In the Scapolite group the various minerals included under that name are generally acknowledged to be isomorphous mixtures of two or more silicates, but different views are held upon the possible constitution of these primary constituents.

Again, there is some uncertainty whether isomorphous mixtures to form homogeneous crystals can take place in all proportions and are accompanied by continuous changes in the physical properties of the substance, or whether they

tend to assume certain molecular proportions as in Dolomite. It is generally assumed now, in consequence of the researches of Dufet and Retgers, that the former is the case, and that truly isomorphous compounds can graduate into each other by imperceptible variation of mixture.

Be this as it may, we are obviously compelled to admit that minerals such as Calcite and Dolomite, though not isomorphous in the strictest sense, possess a similarity both of form and of composition, and, whether their similarity be indicated by the term species, genus, order, group, or family, they must be brought together in any system of rational classification of which the object is to emphasise and to reveal the resemblances of minerals.

The term species is freely used in mineralogy, but in very different senses. Many authors, in particular Berzelius, Rammelsberg, Fuchs, and Groth, would banish the word entirely from this science. Obviously if Garnet is a species so is the whole group, including Calcite, Magnesite, etc.; on the other hand, if Calcite is a species so is each of the Garnets mentioned above, together with the other compounds conforming to their type of composition $R''_3\ R'''_2\ (Si\ O_4)_3$; so that if R″ may be Ca, Mg, Fe, or Mn, and R‴ may be Al, Fe, or Cr, there are at least twelve species belonging to the Garnets.

Dana, in the fourth and preceding editions of his system, defined a mineral species as "any natural inorganic substance composed of particles capable in favourable circumstances of combining by means of their mutual attractions so as to constitute a crystalline solid". He goes on to say: "The question still arises, *What is distinctively a mineral species?* Since it has been found that in accordance with the principles of isomorphism there are elements which may replace one another indefinitely and still the form of the crystals remain the same, crystallisation has been assumed as the only authoritative test of identity or distinction of species; and this idea has been the means of greatly simplifying the science; the species Garnet would make, according to the old chemical view a dozen or more species. . . . Research may yet discover a principle

(if not already accomplished) which will embrace these seemingly anomalous cases, and establish the canon that *individuals of analogous constitution which are one in crystallisation constitute a single species;* they are at least so far identical as to pertain naturally to a common group, whether we call it a genus or family or species or by any other name."

Tschermak in his *Lehrbuch der Mineralogie*, which is perhaps more largely used for educational purposes than any other text-book dealing with the subject, defines a "Mineralgattung," which he substitutes for the word species, as including all minerals which are identical in chemical composition and in crystalline form. In an isomorphous series of mixtures the division into species is more or less arbitrary and is arranged so as to suit practical convenience.

The author who above all others has frankly accepted this view of systematic mineralogy is Groth, who in successive editions (1874, 1882, 1889) of his *Tabellarische Uebersicht der Mineralien nach ihren Krystallo-chemischen Beziehungen geordnet* has attempted to frame a rational classification in which only composition and form are taken into account, and all minerals are described as simple compounds or as isomorphous mixtures of the same.

In this way minerals are brought together into "groups" which include certain simple compounds and their isomorphous mixtures. In the system of Groth there is much that appears to be highly speculative; in order to secure the two features desired, (1) simplicity of constitution, and (2) an isomorphous relationship between all the members of a group, radicles are introduced in an arbitrary manner, which is not always suggested by the results of analysis.

The assertion in the second edition that Fluorine is replaceable by Hydroxyl, $Ca_2$ or Ca Mg by Na Fe and by Li Al, $Al_2$ by Ca Si, and $Si_2$ by Ca $Al_2$ was not at that date (1882) the enunciation of any generally accepted facts. Subsequent study has, however, in many instances only confirmed the remarkable insight which has led Groth to

predict the composition of some of the less fully investigated minerals; the recent analysis of Leadhillite, for example, by Pirsson and Wells agrees absolutely with the composition which Groth had in 1889 assigned to this mineral in order to express it in the simplest possible manner as a basic sulphate and carbonate.

## NEW SYSTEMS OF CLASSIFICATION.

From what has been said it is clear that according to modern views the true "individuals" which should constitute the units of mineralogy, whether they be called species or not, are all those simple compounds which by their intermixtures and mutual replacements give rise to all the known minerals; they are as it were the letters of the mineralogical alphabet, though they are not all found in nature as minerals.

Their study is in reality part of a much more comprehensive system which shall take into account the characters and relationships of all known crystallisable substances whether minerals or laboratory products; the latter fill gaps in the system which can never be complete without them.

(In such a system non-crystallisable substances occupy a position by themselves, and one of entirely subordinate importance as regards mineralogy; it may be doubted whether more than one such substance, namely opal, occurs as a natural inorganic mineral; earthy minerals we are accustomed to regard merely as amorphous varieties which bear the same relation to possible crystalline compounds that an amorphous precipitate of barium sulphate bears to the mineral Barytes.)

The study of the simple crystalline individuals which are the units of Mineralogy and of Chemistry can only be carried on by the help of their morphological and physical relationships; the important contribution which minerals make to this study is the large number of suggestive isomorphous mixtures which are to be found in the Mineral Kingdom. Upon these is based a system of mineralogical classification which is far more important than any attempt to frame a rigid definition of species.

But the curious feature which particularly deserves notice is this: In proportion as our mineral classification becomes more purely a chemical one as interpreted by isomorphism, so does it depart more and more widely from what was originally meant by a chemical classification; as our views on isomorphous replacement become extended, and radicles which are apparently diverse are recognised as capable of mutual replacement, so is the genetic kinship of minerals as referable to certain acids or bases more and more lost from sight, until ultimately a classification of crystallisable substances on mineralogical principles bears little resemblance to the classification of chemical text-books.

It must be borne in mind that the purpose of systematic mineralogy is not to co-ordinate those characters which are useful for determinative purposes; yet the latter have always exercised an influence upon the classification. At the beginning of the century the external characters alone were used for determination, they were also the basis of classification; somewhat later the necessity of chemical analysis was fully recognised, and the system became purely chemical. It may be that now, since improvements in physical methods render it possible to identify a mineral with accuracy by optical characters, specific gravity, and form, as is constantly done in petrographical research, determinative mineralogy does not lend such strong support as formerly to a rigidly chemical definition and classification of mineral species.

To be bound now to any system which necessarily classes together all silicates or all oxides is only to be hampered by preconceived interpretations of the analyses. The symptoms of dissatisfaction with such a system are widespread, and in extreme cases almost express themselves by an apparent return to the old Natural methods in which the composition was of no account; well-defined natural groups are accepted on grounds of general similarity in characters, and attempts are then made to explain the chemical constitution as also indicative of the same similarity.

A great deal dates from the discovery that the plagioclastic Felspars must be regarded as isomorphous mixtures of the two compounds Na Al $Si_3$ $O_8$ and Ca $Al_2$ $Si_2$ $O_8$, a relation which later investigation has established more firmly than ever. In whatever way such a relation is explained, whether by regarding Ca as capable of replacing Na, and Al of replacing Si, or by supposing Ca $Al_2$ to be capable of replacing $Si_2$, the exigencies of this and similar cases lead far beyond the old conceptions of isomorphism, and introduce radicles which result in quite a new mode of chemical classification.

The replacement of Fluorine by hydroxyl, for example, enables us to refer many so-called hydrated compounds to a natural position among anhydrous groups. Thus Swabite, a newly discovered hexagonal mineral having the composition $H_2O$. 10CaO. $3As_2O_5$, can in the form (CaOH) $Ca_4$ $(AsO_4)_3$ be reasonably referred to the Apatite group (Ca F) $Ca_4$ $(PO_4)_3$, to which it bears much resemblance.

These principles are being extended every day. Brögger and Bäckström have proposed to include in the Garnet group the minerals Sodalite, Nosean, and Lapis-Lazuli, which were formerly either allied with Nepheline as alkaline silicates, or were placed in separate groups as silicates combined with chlorides and sulphates. They suggest, in order to bring them into harmony with the Garnet type $R_3$ $Al_2$ (Si $O_4)_3$, the following formulæ :—

Sodalite $Na_4$ [Al Cl] $Al_2$ (Si $O_4)_3$.

Nosean $Na_4$ [Al (Na $SO_4$)] $Al_2$ (Si $O_4)_3$.

Lapis-Lazuli $Na_4$ [Al ($S_3$ Na)] $Al_2$ (Si $O_4)_3$.

Again, according to Brögger, another group of minerals which present remarkable resemblances in crystallographic and physical characters include certain silicates, aluminates, ferrates, and manganates conforming to a general type of formula $R_2$ Si $O_4$ and $R_2$ $X_2$ $O_4$, where in the silicates R may be any of the elements Ca, Fe, Mg, Mn, Zn, Be, or the radicle ($H_2$ Cu), while in the aluminates and other compounds it may denote Be, $H_2$, or $Mg_2$ O; X being Al, B, Fe, or Mn. This unites into one mineral group

Chrysoberyl, Diaspore, and Manganite; Ludwigite and Pinakiolite; Olivine, Phenacite, Willemite, Dioptase and Trimerite; minerals which are generally dispersed among the groups of Oxides or Hydrates, Borates, and Silicates.

It would be easy to multiply examples, but the above will be sufficient to illustrate the direction in which modern views on mineral species are tending.

Though veiled, the conflict between Natural-historical and purely Chemical modes of classification still continues; but it is now mainly a question of interpretation. Mineralogists are pretty well agreed upon the composition, the form, and the other essential characters of crystallised minerals; they are also agreed upon the futility of placing such characters as hardness, lustre, colour, etc., in a position of equal importance with the measurable physical and chemical characteristics. Instead, however, of endeavouring to define each species or to say where it begins and ends, they will be better occupied in studying the variations and ascertaining how the different characters vary together. Sooner or later this will lead to an entire revision of the present system, and probably on the lines indicated in the last paragraphs.

We may then hope to reduce the complication at present prevailing in the Mineral Kingdom to an orderly variation within certain well-defined and comprehensive groups, each of which may include various chemical types and various crystalline systems, and to understand them as the direct expression of the laws which govern the nature and arrangement of the ultimate particles in crystallisable compounds.

H. A. Miers.

# INSULAR FLORAS.

## PART V.

THE botanical exploration of the African islands of the Indian Ocean has now reached a point that further discoveries will hardly lead to further problematical questions in relation to the geographical distribution of plants. Numerous species still lie undescribed in herbaria, and doubtless many have not yet been collected, and probably new generic types may yet be discovered; but were every genus and species known we should be in no better position than we are at present for discussing the composition and origin of the flora of these interesting islands.

I will take Madagascar first, because so much has been written on the relationship of its fauna and flora; and, I may add, because the peculiarities of its flora, at least, have been exaggerated and the affinities misunderstood. Following up Mr. J. G. Baker's investigations, to which I shall have occasion to refer again, I, some years ago, attempted to demonstrate (1) that the flora was essentially African in character, and the enormous accumulation of data since then fully confirm the views there set forth.

I was impelled to an examination of the facts in consequence of the importance attached by Dr. Wallace (2) to the apparent Asiatic affinities of the flora and its dissimilarity from the African flora of the same latitude. This view is even emphasized in his later work (3), from which I quote the following sentence :—

"As examples of extreme diversity, notwithstanding geographical proximity, we may adduce Madagascar and Africa, whose animal and vegetable productions are far less alike than are those of Great Britain and Japan at the remotest extremities of the great northern continent; while an equal, or perhaps even a still greater, diversity exists between Australia and New Zealand".

Now, I believe that it will be generally admitted that

the facts adduced below entirely invalidate the foregoing statement. Not only is it inaccurate as regards Africa and Madagascar, but the comparison of Great Britain with Japan is singularly unfortunate, so far, at least, as the flora is concerned. It is true that there is a northern flora extending from the Atlantic to the Pacific, and including Great Britain in its area, which is essentially the same from sea to sea. It is also true that Britain and Japan have a number of genera and some species in common; but here the resemblances cease. In Britain there is practically no endemic element; there is very little variety in evergreen trees and shrubs, and there is very little variety of shrubs and trees with conspicuous flowers. In Japan all these conditions are reversed; and there are local endemic types, or such as it has in common with China, which are equally peculiar and distinct in their way from the British as those of the Ethiopian Region, by which I mean Africa and the islands. It would unduly lengthen this article to enter far into particulars of the Japanese flora, but it may be explained that it is a part of what may be termed the Chino-Japanese flora, which is intimately connected with that of the Himalayas, and very different from that which forms a belt in a somewhat colder northern zone, from the Atlantic to the Pacific. The late Maximowicz, who was undoubtedly the first authority on the botany of Eastern Asia, and whose knowledge was based upon several years' residence and journeyings in the Amur country and Japan, published some interesting statistics (4) illustrating the gradual eastward diminution of the absolute numbers and percentages of species having a wide area—that is, either circumpolar, or common to both Europe and Asia. In Baikal-Dahuria they form, approximately, 53·4 per cent.; in Mongolia, 46·2 per cent.; in Mandshuria, 39·6 per cent.; in the Peking district, 31·9 per cent.; and in Japan, 16·2 per cent. The percentages of endemic species in these five areas are respectively: 9·4, 8·3, 8·7, 13·3 and 44·0; from which it appears that there is an enormous increase on passing from the continent to the islands of Japan. Subsequent discoveries in Central and Western China have revealed the

existence of somewhat closer affinities between the floras of China and Japan than were supposed to exist, and have confirmed Maximowicz's description of the abrupt cessation in Mandshuria of what may be termed the element of wide distribution. A striking illustration of the truth of this came under my own observation a few years ago. Mr. H. E. M. James presented Kew with a collection of dried plants made by him and his companions between Moukden and Kirin. The flowering plants were determined (5), and 160, out of about 500, or nearly one-third of the species, were common to the British Islands and Mandshuria.

I have gone so far into particulars concerning the flora of Japan, because it is an insular one, and because its composition has been misunderstood by certain writers.

With regard to the diversity of the New Zealand and Australian floras, it should be borne in mind that it is largely due to the poverty of the former, and the absence of prominent Australian types, rather than the presence of types not represented in the Australian flora. It is true that there is a relatively large endemic element in New Zealand, both generic and specific, but the nearest allies are found in Australia and the outlying islands ; and many of the most abundant and most conspicuous members of the New Zealand flora belong to characteristic Australian genera, or to genera equally common in Australia. The following is a selection : *Pittosporum*, *Hymenanthera*, *Plagianthus*, *Phebalium*, *Pomaderris*, *Leptospermum*, *Metrosideros*, *Coprosma*, *Olearia*, *Ozothamnos*, *Stackhousia*, *Stylidium*, numerous Epacrideæ, *Logania*, *Myoporum*, *Atherosperma*, *Hedycarya*, *Persoonia*, *Pimelea*, *Exocarpus*, *Fagus*, *Podocarpus*, *Dacrydium*, numerous Orchideæ and Liliaceæ, a few Restiaceæ, and *Lepidospermum*. The foregoing list includes a few genera, such as *Stackhousia*, which are abundantly represented in Australia, but rare in New Zealand.

Returning to the flora of Madagascar, I propose giving a condensed account of the data afforded by the scattered literature, and the copious collections of recent years. The botanical exploration of the islands has not been the work of

one nation alone: English, French and Germans alike have participated in it; but in each case by totally different bodies of persons. Thus the collections that have reached this country were made almost exclusively by English missionaries; the French collections were made, to a large extent, under Government auspices; and the German collections by independent explorers. Numerous botanists have contributed to the publication of the plants discovered by the various travellers.[1] The English collections chiefly by Mr. J. G. Baker (6), Mr. H. N. Ridley (7), and Mr. G. F. S. Elliot (8 and 9), who described the plants collected by himself; the French collections almost entirely by Dr. H. Baillon (10 and 11); and the German collections by various botanists (12 to 18). Dr. Baillon long ago commenced an enumeration of the plants of Madagascar (10), but this is still far from complete; and I am greatly indebted to Mr. J. G. Baker for kindly permitting me to use a manuscript index he has compiled to the places of publication of the plants of Madagascar up to the present time. The Rev. R. Baron, who has resided many years in Madagascar, and who is the most successful and persevering of the English collectors, drew up an account (19) of the vegetation and flora of the island, based upon the published material and personal observation. To this article I am indebted for many of the following particulars, somewhat modified in some instances by subsequent discoveries, or publication of previous discoveries. For more complete data respecting the monocotyledons and gymnosperms I have consulted Durand and Schinz (20), whose work, so far as it goes, has been of immense assistance, as it includes the whole of the African Islands, both of the Atlantic and Indian Oceans.

Madagascar, it may be convenient to remind the reader, is situated almost wholly within the southern tropic, and is one of the largest islands of the world, being approximately (21) 1000 miles in length, with an average width of 250 miles, while, according to the same authority, the highest

[1] Only the vascular plants are taken into consideration here.

peaks are very little more than 8500 feet above the level of the sea.

Baron estimated (19) the number of species of vascular plants known as 4100; but Mr. J. G. Baker agrees with me that we may now rightly raise this number to 5000; not that they are all known in the sense of being published, for many yet remain in herbaria undescribed. Nevertheless, for the purposes of this article, Mr. Baron's figures and other data will be used, supplemented by remarks on subsequent discoveries of importance in geographical botany. But these are few; the additional novelties being chiefly of no higher rank than species.

Roughly speaking, the vegetation of Madagascar consists of three zones, namely, the tropical plains, varying in width, from the sea-coast inland; a belt of forest, encircling the interior treeless zone, and also varying in width. Baron reckoned the area of the forest-clad country at 30,000 square miles, or about one-eighth of the island; but the natives are destroying the forest in the most reckless manner. He mentions, for instance, that no fewer than 25,000 trees were cut down to make a passage for a tombstone that had been quarried in a certain place! Should this wanton waste be permitted to continue, many rare plants will undoubtedly disappear.

For purposes of comparison, I propose giving some numbers and percentages for other countries, mainly from tables of my own construction (1, 22, 23,) presuming that in all cases they are merely approximations, though it may be claimed for them that they are based upon fairly uniform computations.

Of the 202[1] natural orders admitted by Bentham and Hooker (24) 144 are represented in Madagascar. The numbers in Central America (including Mexico), British India and Australia are respectively 162, 174 and 154. The number of natural orders of restricted distribution is exceedingly limited, and Madagascar can only claim one small group of plants, the Chlænaceæ, to which this status

[1] Baron erroneously places the number at 200.

is accorded, and not by all botanists. I shall have occasion to refer to the affinities of this natural order in a succeeding paragraph. As a matter of fact, however, it has less decided distinctive characters than some of the aberrant endemic genera of Madagascar; and it does not rank with such orders as the American Bromeliaceæ, Sarraceniaceæ and Calycereæ; or the South African Bruniaceæ and Penæaceæ, and the Australian Tremandreæ. At most, it ranks no higher than the least specialized of the natural orders named.

Bearing on this question, the restricted area of natural orders, it is singular that no natural order is confined to Asia, but there are several—Dipterocarpeæ, Moringeæ and Salvadoraceæ—which are common to Asia and Africa; and the two latter are represented in Madagascar. It is true that if the genera *Ancistrocladus* and *Lophira* be excluded from the Dipterocarpeæ, only one species of this order inhabits Africa against large numbers in Asia.

The number of genera then (1889) known to inhabit Madagascar was 970, and is now probably not less than 1000. Bentham and Hooker (24) describe less than 7600 genera, but the discoveries since the publication of the various parts of that work would probably bring the total up to 9000 upon the broad lines laid down by them. My estimate of the number of genera of vascular plants known to inhabit Mexico and Central America in 1888 was 1849, whereof 1794 were phanerogams. My estimate of the number of phanerogamic genera in the flora of British India was 2271; and Sir F. von Mueller's census of Australian plants gave 1409 genera, including 45 genera of vascular cryptogams. These figures indicate that a large proportion of the genera of vascular plants must have a wide range, and the approximate percentages of endemic genera in each of these regions will give an idea of their relative degrees of concentration in large insular and large continental areas.

In Madagascar 15 per cent. of the genera are endemic; in Central America (including Mexico), 11 per cent.; in British India, 13·8 per cent.; in Australia, 30·5 per cent.;

and in South Africa, 30·5 per cent. Assuming that future discoveries will to some extent raise the percentage in Madagascar, and that the genera of South African and Australian plants have even been unduly multiplied, it is highly improbable that Madagascar will ever show so high a percentage of endemic genera as the countries named.

Comparing the specific endemic element in the Madagascar flora with that in each of the countries named, we obtain similar results. Baron points out the high percentage of endemic species in Madagascar, but he institutes no comparisons. He says: "Of the 4100 indigenous plants at present known in Madagascar, about 3000 are, remarkable to say, endemic". This includes the vascular ferns.

In 1888 the percentage of endemic species of phanerogams known to inhabit Central America and Mexico was 70·5, and since that date numerous genera and several hundred new species have been described. Taking a more restricted area in Central America, that is to say, the South Mexican region, as defined in the Botany of the *Biologia Centrali Americana*, I estimated the specific endemic element to exceed 80 per cent. In Australia 84·9 per cent. of the vascular plants are endemic, and taking West Australia by itself, 85 per cent. of the species are endemic in that part of Australia. The extratropical South African flora yields nearly as high a percentage. The percentage of endemic species in British India was found to be considerably lower—barely 69, but within this area there is an overlapping of several distinct floras.

Assuming the foregoing figures to represent about the same value in each case, and there is no reason to doubt this, it will be perceived, that so far as mere numbers are concerned, at least, Madagascar does not present a more highly specialized flora than certain larger and smaller continental areas, and that it is surpassed in this respect by other areas. I believe, too, that these proportions would hold good for the different regions of Madagascar. Baron divides the country into three regions — an eastern, a western, and a central; and he gives the results of an

analysis of the composition of the vegetation in each. The peculiar species are as 2·6 to 1, 2·3 to 1, and 2·4 to 1 respectively out of the total number of species known from each region.

It should be added, moreover, that Mr. Baron finds that the floras of the eastern and western regions differ very widely, which he explains by assuming great age for the elevated central region dividing the two. He states that apart from 100 species which are common to all three regions, only 128 are common to the eastern and western regions. But it would appear the diversities are largely specific rather than generic, and no greater than those existing in contiguous valleys of the great mountain masses of Eastern India and Western China.

Passing from statistics to the composition and affinities of the endemic element in the flora of Madagascar, we approach a more interesting subject. It is convenient to discuss this in relation to the rank of the groups, whether ordinal, generic, or specific. As already mentioned, the only group of plants endemic in Madagascar to which ordinal rank has been assigned are the Chlænaceæ. Whether regarded as an order, or as a tribe of the Ternstrœmiaceæ, as proposed by Baillon (25), there is no doubt that they form a group of very curious genera, mostly characterized by having an involucre, or epicalyx, and a cylindrical or cup-shaped organ called a disk, within and upon which the stamens are seated. They are shrubs and trees; one species being as much as a hundred feet high. Seven genera have been found, and about twenty-eight species. According to Baron, the majority of them are found in the eastern part of the island, and the genus *Rhodolæna* is confined to that side. The only species of *Sclerolæna* inhabits the north and north-west, and the four species of *Xerochlamys* occur on the hills and mountains of the interior. *Leptolæna pauciflora*, an eastern member of the order, "is a hard-wooded tree, from the trunk and branches of which, at a certain season of the year, there is a ceaseless dropping of water, sufficient indeed to keep the ground quite damp".

Some of these Chlænaceæ, such as *Rhodolæna altivola* and *Sarcolæna grandiflora*, have large showy flowers.

A few of the most peculiar and striking plants of Madagascar are so well known that it is hardly necessary to mention them. For example, *Angrœcum sesquipedale*, *Ouvirandra fenestralis*, and *Ravenala madagascariensis*. The last is often cited as an instance of American affinity not represented in continental Africa; and indeed it is the most remarkable and prominent of the endemic plants.

Among the 150 endemic genera, exclusive of the Chlænaceæ, some stand out so conspicuously from the rest as to demand special notice; but space will only permit of a few words concerning some of the more curious or prominent. *Didierea* (26) is an aberrant type, exceptional alike in habit and floral structure, which Baillon refers to the Sapindaceæ, though it presents so many points of difference that perhaps it deserves the rank of a natural order equally as much as the Asiatic *Dobinea*, recently raised to that dignity by the same author. Two species of this singular genus are now known, both from the south-west of the island. The first discovered, *Didierea madagascariensis*, grows gregariously on the dry plains near Tulear, covering considerable expanses. It has a thick, fleshy stem, simple, or very little branched, recalling the columnar *Cacti*, but it is not fluted; and the small, linear leaves and flowers are in clusters, protected by groups of formidable spines, springing from the same protuberances or cushions. The flowers are unisexual, and the floral envelope consists of three decussating pairs of organs, the innermost of which are the smallest. There are eight stamens, and the three-celled ovary with one ovule in each cell matures in a one-seeded triangular fruit, surmounted by a very large three-lobed corrugated stigma. The second species, *D. mirabilis*, has a stout trunk about twenty inches in diameter, giving off horizontal branches at a few feet from the ground, the whole plant rising to a height of twelve to fifteen feet.

Among the Leguminosæ are several remarkable types, notably *Neobaronia* of Baker, which, however, had been

previously described by Baillon under the expressive name of *Phylloxylon* (27). It has broad, sometimes branched phylloclades, bearing flowers on their margins, succeeded by short, coriaceous ovoid pods. Imperfect specimens had long lain undescribed in herbaria. *Polycardia* is a singular genus of the Celastrineæ, characterized by the flowers being borne in clusters on the leaves. In *P. centralis* they are borne on the midrib in the middle of the upper surface of the leaf; in *P. Baroniana* (28) they are borne in a lateral sinus; and in *P. phyllanthoides* they are borne in an apical sinus. In all cases they originate from the midrib of the leaf. Structurally, however, the genus hardly differs from *Celastrus* itself, to which Baillon has reduced it. Complete specimens of Thouars's doubtful genus *Dilobeia* have been collected, proving it beyond question to belong to the Proteaceæ. Baillon has figured it (29), and the genus is apparently monotypic. The broad leaves are doubly bifid on the young trees and barren branches, and singly bifid on the flowering branches, with a large saucer-shaped gland in the base of each sinus; and the inconspicuous flowers are diœcious. *Trimorphopetalum* (30) is a distinct new generic type, most nearly allied to *Impatiens*, and described as having two small green lateral sepals and a large petaloid, hood-shaped posticous one, and three petals, of which the anticous one is similar to the posticous sepal, and the lateral ones are orbicular and narrowed into a claw. *Tisonia* (31) is an equally singular new type of the Bixineæ. It has apetalous, hermaphrodite flowers with three large sepals, which grow out into a three-winged organ enclosing the fruit. Many other curiously aberrant types might be noted, but those indicated are among the most interesting. Yet I would not be understood as laying great stress on this fact, or attaching great importance to it, because relatively this feature is no more pronounced in Madagascar than it is in Bourbon and the Seychelles, to say nothing of continental Africa. To give examples from other countries, however, is beyond the scope of these articles.

Not less interesting than the endemic genera are the endemic species of some notable genera, especially in

relation to the distribution of generic types. Foremost among these are the Baobabs (*Adansonia*), of which, according to Baillon (32), there are several species in the island, so that the solitary tropical African species and the remote Australian one may be regarded as outliers of a genus having its greatest concentration in Madagascar. There is evidence, too, that the insular species sometimes attain very large dimensions; a trunk with a diameter of twenty-two feet at six feet from the ground being on record. The characteristic *Kigelia* (Bignoniaceæ), on the other hand, is represented by one species in Madagascar and several in Africa. *Hibbertia Aubertii* (Dilleniaceæ) is a solitary outlier of an Australian genus numbering upwards of fifty species, with three or four others in Polynesia. With regard to the phyllodineous *Acacia heterophylla*, which is an Australian type, and which is generally considered to be indigenous in Bourbon and Mauritius, Baron enumerates it among the introduced cultivated plants in Madagascar; and Mr. J. G. Baker informs me that he is now convinced that the form he described as a new species under the name of *xiphophylla* is only a cultivated state of *A. heterophylla*. It is possible that there is still something more to be learnt about this species, as it is hardly distinguishable from the Hawaiian *A. Koa*. *Nepenthes* is a noteworthy essentially Asiatic genus represented in Madagascar by one species, but not reaching Africa. The discovery in Madagascar of a species of the parasitic genus *Cytinus* is of more than ordinary interest, because the present distribution and relative rarity of plants of this class (and also saprophytes) indicate their gradual extinction. They seem to have disappeared from large areas, consequent on the early destruction of forests, and to have survived in remotely distant localities, where the conditions remained favourable to their existence. Mr. E. G. Baker describes (33) *Cytinus Baroni* as differing from all the other species of the genus in growing on the trunks of trees, instead of on the roots of other plants. *Cytinus* is closely related to the gigantic *Rafflesia* that grows on the roots of vines in the Malay Archipelago. Of the four

species of *Cytinus* previously known, two inhabit Mexico, one the Mediterranean region, and one South Africa, thus offering a good example of a genus of widely separated areas.

Another remarkable discovery is described (34) by Baillon. It is a probable saprophyte (*Geosiris aphylla*), a member of the Irideæ, and the only one at present known that is destitute of chlorophyll. The floral structure of this plant presents no anomalies, but being of a dirty yellow colour, and only about three or four inches high, it easily escapes observation, and so far has been collected by only one person, and in only one locality.

With regard to palms in Madagascar, expectations have hardly been realised, only about a score of species having been recorded; although, as Baron says, there is doubtless a larger number in the island. Palms are not easily collected, and specimens are troublesome to preserve and carry about; hence we may expect some augmentation of the number at present known, though it is evident that they are not numerous. From specimens collected by Mr. Baron and preserved at Kew, I am able to add two important genera to Durand and Schinz's enumeration (20), namely, *Hyphæne* and *Phœnix;* the species being *H. coriacea* and *P. reclinata*, both of which also inhabit continental Africa. The former is a palm of small stature, covering the whole face of the country, according to Baron, in some districts on the western side of the island; but he is wrong in supposing it to be endemic, as it inhabits Eastern and Central Africa, from Abyssinia to Natal and Cape Colony. *Raphia Ruffia* is another palm the island possesses in common with continental Africa. *Borassus* and *Elæis*, two specially African types, are not known, I believe, to occur in Madagascar; and the large Asiatic genus *Calamus* has not hitherto been found in the island, though there is one endemic species in Africa.

At the time of the publication of the *Flora of Mauritius* (35) almost nothing was known of the vegetation of the smaller islands and groups of islands, such as the Amirantes, Aldebra, Agalega, Glorioso and others, except

that mangroves and coco-nut palms abounded; and comparatively little was then known of the flora of Madagascar. The Seychelles are included in Baker's *Flora*, and the absolutely unparalleled concentration of endemic palms in those islands was, and is, the most remarkable feature brought to light in the vegetation of the islands of the Indian Ocean; but neither the subsequent investigation of many of the smaller islands, nor the very extensive and general exploration of Madagascar, has revealed the existence of one of these palms outside of the Seychelles group. Two or three other plants previously only known to inhabit the Seychelles, or Mauritius, as I shall presently show, have been found in some of the smaller islands, but not one of the palms. About half of the Madagascar palms belong to the endemic genera *Dypsis* and *Phloga*, and almost all the other species are endemic. With the exception of the Cocoineæ, all the six tribes of the Palmæ are represented in the islands of the Indian Ocean; the tribe in question being present only by the cultivated coco-nut palm.

A still more prevalent feature than palms in the vegetation of Madagascar and the other African islands of the Indian Ocean are the screw-pines. They abound all over the smaller islands, but in Madagascar they are more specially characteristic of the lower zone of vegetation. The Pandaneæ, or screw-pines, are nearly confined to Polynesia, Malesia, the East African islands and East Africa, and the genus *Pandanus* itself has its greatest concentration of species in the Mascarene Islands, using the term in its widest sense; every island, or group, such as Mauritius, Bourbon, Rodriguez and Seychelles, having its endemic species. Nearly a score of endemic species are known to inhabit Madagascar, and, considering that they are diœcious, and even more difficult to collect than palms, probably this number by no means exhausts the total. It may be added that the palms and screw-pines of the Seychelles are well depicted in the North gallery at Kew. Another point connected with the endemic element in the Madagascar flora is the fact that much more than half

of the genera are monotypic, and exceedingly few number half a dozen species; whereas many genera of almost world-wide distribution are represented by numerous endemic species. Examples are: *Hibiscus*, *Grewia*, *Vernonia*, *Helichrysum*, *Euphorbia*, *Acalypha* and *Cyperus*. To these might be added examples of genera essentially of the African region, of which there are numerous species endemic in the island, namely, *Psorospermum*, *Dombeya* and *Angræcum*.

Wallace long ago pointed out the rarity of masses and stretches of colour in the vegetation of the Malay Archipelago, and other travellers in tropical regions have been impressed by the want of colour as compared with temperate regions. Mr. Baron says of Madagascar: "There are comparatively few plants having beautiful flowers. There are no meadows anywhere in the island that can at all compare with our English meadows for floral beauty. Neither do the forests supply what is lacking in the meadows. Any one entering a Malagasy forest with the anticipation of seeing innumerable beautiful flowers would be utterly disappointed, for they are extremely rare." This does not imply that large and brilliantly coloured flowers do not exist—larger and more brilliant than are to be found at home perhaps; but, as Baron remarks, they have to be looked for.

Coming to the "character and relationship of the Madagascarian flora," Baron relies mainly on Baker's details and generalizations (36), which, though put forward some fifteen years ago, still hold good, and indeed have been strengthened by subsequent discoveries. Briefly, there is a close affinity between the tropical flora of Madagascar, Bourbon, Mauritius and continental Africa, with a few isolated Asiatic types in Madagascar that do not occur in Africa. There is perhaps an even closer relationship between the upland flora of Madagascar and the flora of the mountains of tropical Africa and temperate South Africa. Identical species occur in Madagascar and the mountains of the most distant parts of Western Africa. Noteworthy among these species common to continental Africa are *Viola abyssinica*, *Geranium simense*, *Caucalis melanantha* and *Agauria salicifolia*; the

last an ericaceous shrub, common to the mountains of Bourbon and Eastern and Western Africa. Again, many specially African genera are represented by different species in the island and continent. Mr. Scott Elliot's later contribution to the botany of Madagascar (8) contains descriptions of a large number of new species and two new genera, with figures of some of the more striking or interesting species collected by the author, chiefly at Fort Dauphin, in the extreme south-east of the island. There is nothing of a highly novel or peculiar character in this collection, the large majority being new species of genera spread over the whole island. Two species of *Tisonia* (Bixineæ), two of *Leptolœna* (Chlænaceæ), *Quivisia grandifolia* (Meliaceæ), *Calantica lucida*, and seven species of *Homalium* (Samydeæ); *Leucosalpa madagascariensis*, a new genus of Scrophularineæ; *Forsythiopsis australis*, and *Camarotea soutensis*, a new genus of the Acanthaceæ; and upwards of a dozen orchids, are the most noteworthy of this collection. From Mr. Scott Elliot's narrative of his journey (9), from Antananarivo to Fort Dauphin, a few interesting particulars may be gleaned, but there is no attempt at a complete description of the vegetation or analysis of the flora.

From the foregoing somewhat disjointed account of the flora of Madagascar, it is evident that, although it contains a large endemic element, it is essentially African; and every extension of exploration in Eastern Africa brings further proofs of the close connection.

There is one work (37) on the mountain flora of tropical Africa, with full particulars of the distribution of all the species, that I had almost forgotten to refer to, yet it contains a mass of information, including the extensions to the islands.

Hildebrandt's sketch of the natural history of the Johanna Islands (16) is of the most general kind, and contains no botanical facts of importance.

I have mentioned Rodriguez in some of my comparisons, and I may refer (38) to the latest and only full description of its flora. With regard to Bourbon, which is known to possess a strongly endemic flora, the only con-

tribution since Maillard (39), containing some of the cellular cryptogams, is the first part (40) of the long promised *Flora*. It contains the vascular cryptogams, and includes 197 species of ferns, of which twenty-three are regarded as peculiar to the island.

Since the publication of Baker's *Flora of Mauritius* some of the outlying islets have been more thoroughly explored, with interesting results; among them Round Island. This is one of several small volcanic islands at the north end of Mauritius. It is situated about thirteen miles from the mainland, rising like a dome out of the ocean to a height of a little more than a thousand feet, and is a mile across in its greatest diameter. Surgeon-Major Johnston states (41) that the greater part of the surface of the island is composed of bare rocks of volcanic tuff, from which almost all the soil has been washed away into the sea by heavy rains. From a distance the island has a very barren aspect, its steep, brown, rocky sides having only small clusters and scattered individuals of palms and screw-pines to break the general monotony of its appearance. Palms and screw-pines are indeed so prominent as to appear to constitute the whole of the arboreous vegetation, though small trees exist of the genera *Terminalia* (Combretaceæ) and *Diospyros* (Ebenaceæ). There are three distinct palms, namely, *Latania Loddigesii*, *Hyophorbe amaricaulis* and *Dictyosperma album*. All three are common in the island, and the second is not known to exist elsewhere in a wild state. The only screw-pine (*Pandanus Vandermeerschii*) is also common on this and some of the adjacent islets, but it has not been found on the mainland. Major Johnston also observed several plants of *P. utilis*; but the conditions under which they were found suggested the probability of their having sprung from seeds sown by one of the early visitors. *Lomatophyllum borbonicum* (Liliaceæ) is another noteworthy native plant. It is of tree-like habit, resembling an *Aloe*, and inhabits Mauritius, Bourbon and Aldabra.

Altogether about forty species of vascular plants are recorded from Round Island. Except the almost certainly

introduced sow-thistle and *Ageratum conyzoides*, no Compositæ inhabit the island; and a tree of which neither the flowers nor fruit is known is the only probable representative of the Leguminosæ. There are two or three earlier accounts of the vegetation (41-44) containing some interesting particulars, most of which, however, are embodied in Johnston's report.

Some of the more distant of the outlying dependencies of Mauritius have recently been more or less explored. These are the Agalega and Aldabra Islands. The Agalega Islands, in about 11° south latitude, are still botanically unknown, but some particulars of their size and vegetation are given in an official report (45), of which there is a copy in the Kew library. It is, however, improbable from their size and elevation that the flora contains any endemic element. Agalega Islands are two in number, designated North and South; the former about five, and the latter about six, miles in length, connected by a sand bank. *Casuarina* and coco-nut trees are the prominent features in the arborescent vegetation; but there are "other trees," concerning which no more is said. Yet from the beginning of the century the coco-nut has been extensively cultivated, and there has been a considerable, and the only, industry in palm oil. But these islands, though nominally English possessions, are practically French, being owned and worked by a French company.

A more interesting flora is that of Aldabra Island, some ten degrees west of the Agalega Islands.

Aldabra Island has long been famous as the home of the gigantic tortoise (*Testudo elephantina*); but until recently the only account of the vegetation was to the effect that the shore was fringed with mangroves, and the whole surface covered with forest. Such is not now the case, whatever it may have been in earlier years. The island is described as about 30,000 acres in extent, is situated to the northwest of Madagascar in 9° 30° south latitude, and presents no greater elevation than 200 feet. Dr. W. L. Abbott, an American gentleman, visited the island early in 1893, and made a collection of "most of the native plants," which he

presented to Kew. In a letter to the Director (46) he states that the only trees now in Aldabra are casuarinas and mangroves; the latter some of the largest he had ever seen, being sometimes as much as eighteen inches in diameter, and fifty to sixty feet high. This is indeed an unusual size for *Rhizophora mucronata*, the only kind of mangrove in the collection of dried plants. "Formerly," he continues, "porcher [*Thespesia populnea*] and rosewood [*Cordia subcordata ?*] grew to considerable size, as shown by decaying stumps; now, only small ones exist. On the other hand, herbaceous plants are exceedingly scarce. Almost the entire vegetation consists of shrubs of from three to seven feet high. But the soil is thin, and the drought and heat often excessive." He adds that the most conspicuous plant was a kind of *Aloe?* This proves to be *Lomatophyllum borbonicum*, a liliaceous plant, very similar to an aloe, but differing technically in having a fleshy fruit. It was previously only known to inhabit Mauritius and Bourbon.

The collection referred to above has been worked out at Kew. It contains several interesting plants besides the one just mentioned, and a full list has appeared (47) with descriptions of the novelties; the latter more numerous than would have been expected from so small an island with so slight an elevation. It is necessary, however, to repeat the caution that further exploration of the nearest small islands, to say nothing of Madagascar, may lead to the discovery of some or all of them beyond Aldabra Island. Mr. J. G. Baker describes as new: *Grewia aldabrensis* (Tiliaceæ), *Pavetta trichantha* and *Tricalysia cuneifolia* (Rubiaceæ), *Myrsine cryptophlebia* (Myrsineæ), *Solanum aldabrense* (Solanaceæ), *Hypoestes aldabrensis* (Acanthaceæ), *Clerodendron minutiflorum* (Verbenaceæ), *Euphorbia Abbottii* (Euphorbiaceæ) and *Ficus aldabrensis* (Moraceæ). Among other plants specially interesting on account of their distribution are: *Ochna ciliata* (Madagascar), *Desmanthus Commersonianus* (Madagascar), *Plumbago aphylla* (Madagascar and Europa Island), *Astephanus arenarius* (Madagascar) and *Ficus nautarum* (Mauritius

and Seychelles). Altogether fifty species of vascular plants were collected in the island.

Mr. Abbott also visited many other islands in these seas, notably Providence, Assumption and Glorioso. He did not collect plants, but was of opinion that the last named island was comparatively rich in species. Some few particulars respecting the plants of these islands were published by the writer (48), in relation to insular floras generally. The only point of interest in the list is that it corroborates Abbott's opinion that the Glorioso group is relatively rich in species. Though probably far from a complete collection of the flora of Du Lise, Roches, Providence, Alphonse and other smaller islands, it contained the following trees: *Calophyllum Inophyllum*, *Thespesia populnea*, *Morinda citrifolia*, *Guettarda speciosa*, *Ochrosia borbonica*, *Cordia subcordata*, *Hernandia peltata* and *Ficus nautarum*.

Socotra has been partially explored by such competent botanists as Dr. I. B. Balfour and Dr. Schweinfurth; and the former has published (49) the results, which are of a highly interesting character. The island had previously been visited by various Europeans, who brought away a few plants; but no attempt had been made to work out even these few. Dr. Balfour's *Botany of Socotra* forms a bulky volume, and includes 100 lithographed plates representing the principal novelties collected; yet he says of the flora "what we know is but a small portion of what there is to know". The island of Socotra is traversed by the twelfth parallel of latitude and the fifty-fourth meridian. It is between seventy and eighty miles long, and averages nearly twenty miles in breadth, with limestone plateaux averaging 1000 feet, and granitic peaks upwards of 4000 feet in height. The climate, although dry for a considerable part of the year, contrasts favourably with the neighbouring shores of Arabia and Africa, with comparatively moderate heat. Rather less than 150 miles from the African coast, and rather more from the Arabian, it has a distinctly insular character of great antiquity. The vegetation of the dry, sandy plains of the coast region is essentially of the same type as the

desert regions of the mainland, consisting largely of dwarf, stunted, densely-branched, often spiny and hairy shrubs. The hill-slopes and valleys present a much more vigorous and luxuriant growth, composed of representatives of genera characteristic of the tropics of the Old World; but the arboreous element is limited to trees of small stature, from twenty to twenty-five feet high. It is so dense, however, as to be almost impenetrable in places. "Once out of the valley and upon the plateaux, the scene is quite different. Wide barren stretches of grey limestone, or undulating prairie-like downs, extend on every side, unrelieved, save by an isolated *Dracæna* or tree-euphorbia of stiff erect habit, looking like the remnant of the vegetation of some old geological epoch, or where a lake-like depression, with its brown earth sparingly coated with green herbage, often of rank luxuriance, intervenes. And when we reach the higher altitudes on the granitic range, the vegetation at once impresses one with its sub-temperate character. The arborescent type has almost entirely disappeared. Shrubby composites, such as species of *Psiadia*, *Pluchea* and *Euryops*, and succulent forms of *Senecio* are found, also crowds of *Helichrysum*, many of them strongly aromatic, and scenting the air under the stimulating sunrays; and quaint types such as *Thamnosma*, *Nirarathamnos*, *Gradcria*, *Cephalocroton*, *Cocculus Balfourii*, and others, are frequent. Twiggy, narrow-leaved herbs form a dense, deep carpet on the soil, interrupted here and there by a protruding lichen-covered boulder, and for all the world like the covering of heather on a northern moor; whilst within the shade of the boulders, or in the moisture of the overhanging cliffs in the ravines, bright green herbs, such as *Galium* and *Gypsophila*, nestle in beds of liverwort and moss."

It is in the middle and upper zone of vegetation that a large proportion of the singular endemic types exist. A few of the more specially interesting and curious vegetable inhabitants of Socotra deserve brief mention. *Cocculus Balfourii* (Menispermaceæ) is an erect densely branched, rigid shrub, developing both broad cladodes and leafy

branches; the only instance known in the natural order to which it belongs. As Dr. Balfour remarks, it is one of the most remarkable discoveries of the expedition, not unlike *Colletia cruciata* (Rhamnaceæ), a Chilian shrub, occasionally seen in gardens in this country. *Lachnocapsa* (Cruciferæ) is an endemic, monotypic shrub, having downy cordate pods so like the thick leaves that it is difficult to distinguish them. *Dirachma* is another extremely interesting endemic monotypic genus, which Balfour refers to the Geraniaceæ, with the remark that it appears to be most nearly allied to the South American genera *Wendtia* and *Balbisia*. This is one more of the unexplainable isolated remnants of plants of American rather than Asian or African affinities, corresponding to similiar anomalies in the present distribution of animals. *Thamnosma socotrana* (Rutaceæ) belongs to a genus peculiar to the Mexican region, if we except a South African plant of this affinity still imperfectly known. *Cœlocarpus* (Verbenaceæ) is another new genus, which Balfour finds most nearly allied to the American *Citharexylum*. In this connection I may refer to the turneraceous *Mathurina penduliflora* (38), an arboreous member of the order inhabiting Rodriguez, whose nearest allies are inhabitants of Central America. Indeed, there is very little to separate *Mathurina* from the American *Erblichia*, and Hoffmann (13) describes an *Erblichia madagascariensis*, which is also arboreous, and evidently congeneric with the Rodriguez plant.

Historically, the frankincense and myrrh trees of Socotra are of more than ordinary interest. Most of the species—three or four each of *Boswellia* and *Balsamodendron* (*Commiphora*)—are apparently endemic, though closely related to members of the same genera inhabiting Arabia Felix and Somaliland.

The Leguminosæ are numerically the strongest order in the island; but the only one calling for special remark is *Priotropis socotrana*, which is closely allied to the only other known species, *P. cytisoides*, a native of the Eastern Himalaya and Khasia. In *Punica protopunica* we have what Dr. Balfour, probably correctly, regards as the proto-

type of the commonly cultivated and widely colonized pomegranate (*P. granatum*). The essential difference, briefly stated, is the absence in the former of the second tier of carpels, which is characteristic of the ordinary pomegranate, regarded by some botanists as an abnormal development and a product of cultivation. The leaves are larger and coarser than those of the cultivated pomegranate; the flowers smaller, and the fruit much smaller. It is a small tree, and is abundant on the uplands. *Dendrosicyos socotrana* (Cucurbitaceæ) is singular in the order by its arboreous habit, having a short, thick, fleshy trunk, sometimes a yard in thickness. Balfour says its soft, bare and stout stems, surmounted by a tuft of few slightly pendent branches, give it a fantastic look, possessed by only one or two other plants in the island, namely, *Adenium multiflorum* (Apocynaceæ) and *Dorstenia gigas* (Urticaceæ); the former of which is an exceedingly odd-looking plant, with a gouty trunk a foot or two high, and sometimes as much as eight feet in diameter. *Dendrosicyos* is paralleled in Rodriguez (38) by the arboreous *Mathurina penduliflora* (Turneraceæ), that is, in being a tree, but not in obesity, for it has slender branches, and attains a height of twenty feet. Its nearest ally and the only other tree in the order, besides the one mentioned above from Madagascar, is *Erblichia*, a native of Panama. *Nirarathamnos* (Umbelliferæ) is a very marked aromatic dwarf shrub, inhabiting the hills at an altitude of 4000 feet. *Socotora aphylla* is an endemic monotypic genus of the Apocynaceæ, very similar in habit to an *Ephedra*, and having coronal appendages, and the floral structure generally, more like an asclepiad, but wanting the pollen corpuscles. Several sections of *Euphorbia* are represented, and seven out of the ten species are endemic. Most of them belong to the characteristic African section *Tirucalli*, which extends across the continent to the Atlantic islands, and southward to Cape Colony. *E. arbuscula* is an arboreous species of candelabra-like habit, very similar and nearly allied to the Canary Island *E. aphylla*, rising to a height of twenty feet. *E. socotrana*, belonging to the section *Eremophyton*, is an arboreous leafy

species of about the same dimensions. The last I have to mention individually are *Dracæna Cinnabari* and *Aloe Perryi*, two of the most interesting plants of the island, belonging to types equally prominent in the Canary Islands. These plants yield the Socotran "Dragon's Blood" and "Aloes" respectively; yet, although these products have been articles of commerce for centuries, the trees that yielded them were unknown botanically.

Although the flora of Socotra is still very imperfectly known—perhaps not more than half known as to number of species—nearly 600 species of flowering plants have been collected, and after making a considerable deduction for introductions there remain some 500 indigenous species, upwards of 200 of which are endemic, or at least have not hitherto been found out of the island. The total of species given above represent 314 genera, and 81 natural orders. There are 20 endemic genera, 18 of which are monotypic; and of the genera having a wider range 136 are represented by endemic species, and 98 by endemic species only. Such are the principal statistics of the flora, so far as they are at present known. The proportions of the various groups and subdivisions offer no special anomalies. About seven species to each order and four to each genus is rather low, but future explorations will undoubtedly raise these numbers; and also, probably, as Dr. Balfour suggests, alter the ratio of monocotyledons to dicotyledons, because both the English and German expeditions botanized at a season when few bulbous plants are in flower. As it is they compose 100 out of 565 flowering plants, or 17·6 per cent., which is low for a tropical region, though not for a temperate one.

Dr. Balfour has tabulated and analysed the constituents of the Socotran flora in a most elaborate manner, so that it is possible to follow its relationships generally and the affinities of the endemic forms. Altogether the relationships are much more strongly African than Asian; yet it is also evident that South Arabia forms part of a flora common to Socotra and Abyssinia, with wider western and southern extensions than eastern. But there are some specially

African forms still lingering as far eastward as Afghanistan, notably the very distinct genus *Fingerhuthia* (Gramineæ), which Dr. Aitchison found in abundance (50) in the Kuram valley. We regarded it as the same as the extra-tropical South African *F. africana*, the only other species of the genus; but Boissier (51) describes it as a new species; on exceedingly slender characters, it must be said. This however, though an extreme example, is an isolated one; and although Schweinfurth (52) found the vegetation of Western Yemen and Abyssinia almost identical, the affinities of the floras of South Arabia and Socotra are not nearly so strong as might have been expected. This is evident from a report on the botany (53) of Bent's Hadramaut expedition of 1894.

Balfour's table on the ordinal composition of the phanerogamic flora of Socotra reveals some interesting facts. Leguminosæ stand first with twenty-five genera and fifty-three species, including one endemic genus and sixteen endemic species; Graminæ second with twenty-eight genera and fifty-one species, one endemic genus and five species; followed by Compositæ with twenty-two endemic species; Acanthaceæ with three endemic genera and twenty-one endemic species, out of a total of twenty-seven; Asclepiadeæ, two endemic genera and eight species; and Scrophularineæ takes the sixth place with twelve genera and thirteen species, including one endemic genus and four endemic species. These six orders combined contribute 116 genera, 201 species, eight endemic genera, and seventy-six endemic species. These figures speak for themselves, but the large proportion of endemic species of Compositæ and Acanthaceæ is remarkable, though quite in harmony with the discovery of an enormous number of new species of this order by recent travellers in eastern tropical Africa. Orchideæ are rare in most islands, even in those of moderate distance from continents; due probably in some degree to the absence of favourable conditions. *Habenaria socotrana* is the only species hitherto discovered in Socotra, where it is endemic, and probably rare, as Balfour's party met with it in only one spot. It is described as being closely allied

to *H. attenuata*, a species inhabiting the Cameroons, West Africa, at an elevation of over 7000 species. *Wellstedia socotrana*, figured on the same plate as the *Habenaria*, is a new endemic genus of anomalous structure, which Balfour is inclined to regard as an aberrant member of the Borragineæ, from which it diverges in its capsular fruit, pendulous ovules and an embryo with accumbent cotyledons.

One of Balfour's most detailed tables deals with the affinities and other points of the endemic phanerogams of the flora of Socotra; some of the particulars of which I have already given. This is followed by a table showing the distribution of the genera with endemic species, and several other tables which it is unnecessary to designate. The sum of these facts shows that the flora is essentially African; but, apart from the general Asian element, there are forms which have "relations only in restricted districts in India, or further east, but which have no connections in the intermediate regions". There is also strong evidence that it is a very old flora, though in remote antiquity the island was joined to the mainland of Africa; and the presence of highly specialized African types, now occurring sporadically in distantly separated situations westward to the Atlantic Islands and southward to the Cape of Good Hope, together with isolated instances of exceedingly rare types represented in more distant countries in the same isolated manner, strongly support the view of an earlier tropical African flora than the present, now only existing in widely separated areas. The genera *Aloe*, *Dracæna* (of the *D. Draco* group) and cereus-like species of *Euphorbia* are familiar examples of this doubtless very ancient flora.

Schweinfurth himself says on this point (52), that out of a collection of 790 species of vascular plants made by him in the northernmost part of the Abyssinian highlands, in 1891, half had been collected by him in Arabia the previous year; whilst three-fourths of the remaining half of his Arabian collection had been found by other collectors in some part of Abyssinia. According to this rough computation at least seven-eighths of the species are common to both sides of the Red Sea.

The small island of Perim, situated at the entrance to the Red Sea, was partially botanized by Professor J. Bretland Farmer, who spent a few hours on shore in July, 1891. He collected specimens of eleven species of flowering plants, which he presented to the Kew Herbarium; and as there appears to be no previous account of the vegetation of the island the names of the plants with his notes thereon are here given. The island is slightly elevated above the level of the sea, and is barren to the last degree; at least at the season he visited it. Its undulating surface is covered with boulders, except in the sandy bays, and he understood there were no fresh-water springs; but as he had not time to explore the whole island he was unable to confirm this from personal observation. The plants collected are: *Cleome brachycarpa*, *Corchorus Antichorus*, *Zygophyllum album*, *Z. simplex*, *Trianthema crystallina*, *Cassia obovata*, *Statice axillaris*, *Glossonema Boveanum*, *Cornulaca Ehrenbergii*, *Euphorbia granulata* and *Æluropus arabicus*. With three or four exceptions, these plants range from the Cape Verd Islands across tropical Africa and Arabia to Afghanistan, or North-West India, and two or three have an even wider distribution. Most of the plants were collected in the sandy bays, and a glance at the list is sufficient to give one an idea of the character of the vegetation. Of the shrubby plants the *Statice* was the largest, forming bushes two to three feet high at the most. It is a remarkable species, having short, narrow fleshy leaves; and it has been found in Upper Egypt, Somaliland, Socotra and Arabia Felix. *Cleome brachycarpa*, a slender annual, *Zygophyllum album* and *Euphorbia granulata* were the only really common plants; the *Cassia*, an herbaceous species, and the *Corchorus* were frequent, but small. Of the rest only a solitary plant, or very few individuals, were seen. One of the most singular plants is the only grass met with (*Æluropus*); a few tufts of which were found growing where the boulders bordered on the sand. This grass is common in some places near Aden, and is remarkable for its short, rigid, sharply-pointed leaves, resembling spines.

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# THE RESERVE MATERIALS OF PLANTS.

(*Continued.*)

IT may be considered unlikely that any of the dextrins are to be regarded as true reserve materials. Where they occur they are to be rather associated with the hydrolysis of starch and only very transitory, ultimately becoming transformed into sugar, probably maltose. They may be detected by giving a purple or reddish-brown colour with iodine, as starch gives a blue one. It is not difficult to detect dextrin in pollen tubes and to a less extent in the germinating pollen grain from which the tube proceeds.

Certain bodies giving a somewhat similar colour with iodine have been noticed by Gris (33) and others in the young cotyledons and the first leaves of Ricinus. While resembling dextrin in this respect it is more likely that these are starch grains in course of formation, the colour agreeing with the observations of Eberdt, already referred to.

The study of the sugars as reserve materials is beset with a good deal of difficulty. There is no doubt that a very great variety of these bodies can be ascertained to exist in various plants, and that a great many of them may be looked upon as belonging to the circulating rather than the reserve pabulum. Still there remain many deposits of sugar which must be regarded as referable to the latter category. The forms in which sugar most generally exists in plants are no doubt glucose, maltose, lævulose, and cane-sugar. There are many others, but they exist in smaller quantities and only in particular plants. Raffinose has been shown by O'Sullivan (34) to be present in small quantities in the ungerminated barley grain, and it can be shown that it is available for the nutrition of the embryo, though its nutritive value is on the whole small.

Perhaps most interest centres in the *rôle* played by cane-sugar; it is best known as occurring in quantity in

the shoots of the sugar cane and in the fleshy root of the beet, which are the two sources of the sugar of commerce. But there is a considerable body of evidence pointing to its being the most immediately available form of nutritive sugar, though it is apparently not the form most prominent in the circulating carbohydrates. Brown and Morris (35) in a paper already quoted indicate a probability that it is the first formed sugar in the processes of constructive metabolism, and constitutes the first reserve product on which the cells of the leaf feed. In such cases, what is formed beyond the immediate need of the cells is transformed into the more stable form of starch, as already described. Its nutritive value seems to be higher than that of any other sugar found in the vegetable tissues. Brown and Morris cultivated young excised barley embryoes in a 2 per cent. solution, and found that the growth they showed was almost equal to that they displayed when grown on the natural endosperm of the barley grain. In a 4 per cent. solution even greater growth was noticeable, but a greater concentration did not give good results. Cane sugar exists as such in the ungerminated barley grain as proved by Kühnemann (36) in 1875, and Brown and Morris showed that during germination the quantity was increased threefold. It appears further from their researches that the increased amount is derived from maltose by the activity of the growing tissue of the embryo.

Cane sugar in the leaf has been indicated as the immediate forerunner of the starch deposited in the chloroplastids. Aimé Girard (37) has shown that the formation of starch in the tuber of the potato is dependent on the previous existence of cane sugar in the juices of the plant. Lepley (38) has shown that the starch of the maize is dependent on the same appearance; and Balland (39) has demonstrated the same thing in the case of wheat. Brown and Morris have satisfied themselves that cane sugar forms a large proportion of the sugars existing in the sap of the plant of barley during the various stages of its growth, and that this cane sugar disappears *pari passu* with the formation and accumulation of starch in the seed.

Not only does the cane sugar thus appear to be connected immediately with the deposition of starch but it seems also to be the form which is most closely associated with the ultimate nutritive processes. The investigation of the germinating barley grain shows that while the total quantity of it increases during germination, the greatest increase is found in the young embryo and not in the endosperm.

Another carbohydrate, more resembling starch than sugar, is the inulin which can be obtained from the roots and tubers of a section of the Compositæ. Inulin in these parts exists in solution in the sap, but it can readily be made to crystallise out by the application of alcohol. It is considered to stand in the same relation to lævulose as ordinary starch does to maltose, yielding that form of sugar on hydrolysis. The transformation in the plant is effected by a special ferment or enzyme, which exists in the tissue when metabolism is active (40). The course of hydrolysis proceeds much as in the case of starch, an intermediate body being formed which appears to correspond to the dextrin already described. It is interesting to note that starch does not occur in those parts where inulin is present.

In many plants carbohydrate reserve materials are found to take the form of considerable thickening of the cell walls. That these are really deposited with a view to subsequent utilisation is evident from a study of the seeds of many palms, the endosperms of which consist of little else; the cavities of the cells being almost obliterated, and the small space that is left between the thickened walls containing apparently nothing but a small amount of protoplasm, with which some amorphous proteid matter is mixed.

That the cell walls yield nutritious matter on germination of the seed can be readily seen by microscopic examination of the endosperm as soon as the young embryo has started its growth. The cell walls are then found to be gradually corroded from the line of contact with the embryo, a corrosion which is progressive and continuous so long as the latter remains in contact with the endosperm.

It has been observed moreover in the germination of the seeds of several grasses, where a special provision for its utilisation has been found to exist in the form of a special enzyme. The usual store of cellulose need not necessarily be a thickening of the cell wall, for the original wall itself is used up as the embryo grows.

When cell walls are thickened for the use of the embryo, as in the cases mentioned, the thickening is often considerably modified in its chemical composition, although retaining a close relationship to cellulose. Reiss (58) and E. Schulze (59) have described two particular substances of this character, Reiss naming the first reserve-cellulose, and Schulze giving the name "paragalactan compounds" to the second. The latter have also been called *hemicelluloses;* they are converted into glucose and dissolved by hot dilute mineral acids, which do not affect cellulose proper.

Reiss's body exists in the endosperm of *Phœnix dactylifera*, Phytelephas, and other palms. On hydrolysing it with sulphuric acid there is first formed a compound corresponding to dextrin, but lævo-rotatory. This is followed by a sugar, which is dextro-rotatory, reduces Fehling's fluid, and is capable of fermentation. To this sugar the name *seminose* has been given; it forms with phenylhydrazin acetate a compound which is crystalline. Reserve cellulose cannot be distinguished by microchemical reactions from ordinary cellulose.

Schulze has investigated Reiss's body and includes it under the name *mannose* among his hemicelluloses.

Paragalactan occurs in the thickened wall of the cells of the embryo in certain Leguminosæ. It yields on oxidation mucic acid; on heating with dilute sulphuric acid, galactose, and a pentaglucose. When heated with phloroglucin and hydrochloric acid it gives a red colour, but not in the cold as lignin does. It is hydrolysed into sugar by 1 per cent. hydrochloric or sulphuric acid, and is not coloured blue by chloriodide of zinc.

The accumulations of mucilage in definite areas or layers in certain seeds seem to have the same purpose as

these cellulose-reserves. The cell wall, thus, as well as the cavities of the cells must be examined carefully, in estimating the carbohydrate reserve materials.

During the last few years a great deal of research has been directed to ascertaining exactly what is the composition of this cell-membrane, and it has resulted in establishing clearly that instead of this being fairly uniform in its composition, and consisting of cellulose, and the products of its decomposition, it is an extremely complex substance, varying in different cases and usually containing, besides cellulose, a certain, often considerable, amount of substances till recently somewhat crudely described as pectic bodies.

The investigation of these latter is not a new departure. Long ago Fremy studied them carefully as far as the chemistry of his time would permit, and he has described certain of them which he found to exist in the pulp of certain fleshy roots, particularly those of the carrot and the beet. Fremy (41) pointed out that some substance which he named *pectose* existed in the cell wall side by side with cellulose, and spoke of its conversion by the action of a special enzyme into two gelatinous bodies, to which he gave the names of pectosic and pectic acids. These were the result of the hydrolysis of pectose and differed from each other in the amount of water they severally contained.

In more recent years these pectic bodies have been the subject of several papers by Mangin (42), who has made extended investigations into their occurrence in almost all the larger groups of the vegetable kingdom. He finds them in Algæ, Fungi, Mosses, Vascular Cryptogams and Phanerogams, in most organs and in most diverse plants.

As the result of his work, we may say that at least four definite bodies may be prepared, which have been by the older writers included vaguely in the one term pectic bodies. These may be divided into two groups or series of bodies, for there seem to be probably intermediate ones between those clearly established; the two series differing from each other in that one consists of neutral, the other of acid ones. The reason for supposing that intermediate members of each series exist

is that the two members of each merge into one another very gradually; in fact, each series suggests several different substances, presenting a number of gradations from absolute insolubility in water to complete solubility, through gelatinous states characterised by the power of absorbing different quantities of water, and showing various degrees of swelling in consequence.

The neutral series includes *pectose* proper, which is the body associated most generally in cell wall with cellulose. It is not found in such cell walls as have been modified by incrustation or impregnation with lignin or suberin. It is insoluble in water or in ammonia-cupric oxide, by which reagent it can be separated from cellulose.

The second body of this group is *pectine*, which is soluble in water and readily forms a jelly. It swells up at once on the addition of water, yielding a viscid liquid, which filters with difficulty and speedily gelatinises. This seems to be the body Fremy found in many ripe fruits; Mangin has detected it in many of the so-called mucilages.

The acid series includes two forms, of which the first is described as pectic acid. This is very insoluble; it is found in the tissues usually combined with alkaline earthy bases, forming often pectate of calcium. The second, the most stable of them all, is metapectic acid, is soluble in water, but is capable of gelatinisation.

The two series are closely related to each other; under the action of heat, acids, and alkalis, we can, starting from pectose obtain all the neutral and acid intermediate bodies up to metapectic acid.

Pectose is the most unstable; the chemical reagents used to prepare it easily transform it either into pectine or into pectic acid. Even the ammonio-cupric oxide solution used to separate it from cellulose rapidly effects the transformation of part of it.

Pectine can be prepared in quantity from the roots of the carrot. The most satisfactory method of procuring it has been described by Bertrand and Malliose (43). The pulp of the carrots is pressed and boiled for fifteen minutes to free it from the enzyme which sets up gelatinisation, and

filtered on a hot filter. The residue is then macerated for twenty-four hours in 2 per cent. hydrochloric acid, and pressed dry. The acid liquid dissolves the pectine. After filtration an equal volume of strong alcohol is added and the pectine is thereby thrown down as a flocculent precipitate. This is gathered on to a filter and washed with alcohol to which 2 per cent of hydrochloric acid has been added. To free it from the acid it is then dissolved in water and precipitated by alcohol, the process being repeated several times. As the acid disappears the pectine becomes more and more gelatinous, and will ultimately pass over into a colloidal state. This is prevented by not carrying the washing too far, but neutralising the last trace of acid with a weak alkali.

The action of the enzyme, or *pectase*, described by Fremy as producing pectosic and ultimately pectic acid, seems in the light of the work of the last quoted observers to be dependent on the presence of a small quantity of a soluble calcium salt, the resulting body not being pectic acid, but its calcium compound. The clot or jelly produced is insoluble in weak alkalis, but dissolves readily after being macerated in weak hydrochloric acid, and the solution is found to contain a small quantity of lime.

The application of the lime or other earthy alkaline salt in the coagulation needs careful watching, for if too great a quantity be added other gelatinous pectinates are produced. They can be distinguished from the proper coagulation product by being treated with weak hydrochloric acid, which displaces the pectic acid and the pectinate. If only the latter form the jelly, everything goes into solution; but if the pectate of calcium has been formed, pectic acid is set free by the acid, and this is insoluble.

Pectic acid, indicated by Fremy as the ultimate product formed during the coagulation or gelatinisation, is the oldest known of these bodies and gives the most distinctive reactions. It is insoluble in water, in alcohol, or in acids; it forms compounds (pectates) with the alkalis which are soluble in water, and others with the alkaline earths which are insoluble. The lime salt is the most widespread in

vegetable tissues. When dissolved in alkaline carbonates its solutions are mucilaginous and hard to filter; when oxalate of ammonium is the solvent they are perfectly fluid and filter with ease.

Metapectic acid has been identified with arabic acid. It has an acid reaction, is soluble in water and forms soluble salts with the alkaline earthy bases, differing thus from pectic acid. This body and its compounds are met with very frequently in living tissues. It can easily be prepared by boiling pectine, or pectic acid, with excess of alkali.

When heated with sulphuric acid Schreibler (44) says it splits into an organic acid and a dextro-rotatory sugar, which crystallises in beautiful prisms and is identical with *arabinose*. It may therefore be a glucoside.

These pectic bodies differ thus materially from the cellulose with which in cell walls they are so closely associated. Like the latter they can be claimed as reserve materials, from the localities of their occurrence and their ultimate transformations. The relation in which they stand to cellulose on the one hand and to such carbohydrates as starch on the other is not very clear. Probably they had best be regarded as forming a third group by themselves, approaching rather the gums and mucilages. Indeed, many of the reactions which they show have for a long time been described as those of a certain number of the latter.

Mangin has published a considerable number of reactions with different staining fluids which are distinctive of the pectic bodies, and enable their distribution in the cell wall to be ascertained with fair accuracy. They are of course only suitable for micro-chemical determination. The best of them are neutral or slightly acid solutions of phenosafranin, methylene blue, Bismark brown, fuchsin, and methyl violet B. They stain the pectic bodies, as well as lignified and suberised membranes, but the colour can be washed out from the latter in alcohol, glycerine, or acids. Further distinction between these two groups can be drawn by using other stains which act in the reverse manner, leaving the pectic bodies uncoloured while

they stain the lignified and suberised ones. Such colours are acid green, acid brown, nigrosin, and indulin. It is possible by appropriate treatment with these two groups of stains to obtain double-stained preparations of such cell walls.

Mangin also describes the action of certain staining reagents which, while staining pure cellulose and the callus of sieve tubes, leave pectic bodies colourless. Such are orseille red A, naphtol black, Congo-red, azo-blue, and benzo purpurin.

Apart from their behaviour to stains we find a marked difference from cellulose in the reaction of the pectoses to ammonio-cupric oxide solution, in which they are altogether insoluble. They are not stained blue or violet with iodine, even in the presence of sulphuric acid or of the metallic chlorides. When warmed with dilute nitric acid they are slowly oxidised to *mucic* acid, which can be recognised by its characteristic crystals, whereas the cellulose bodies under similar conditions give rise to oxalic acid.

Their relations to gums has been investigated by Giraud (45) who says that some of the latter contain considerable amounts of them, one yielding more than half its weight of a body insoluble in water, apparently identical with Fremy's pectose. It may, indeed, be that gums may be derived from these pectic bodies present in the cell wall, and not the result of cellulose degeneration.

The distribution of oily reserved materials is very varied, though as in so many other cases the seed is the most general place of deposition. Many seeds, as that of the castor oil plant, contain as much as 60 per cent. of their dry weight of oil, which is non-volatile. Others contain as little as 2 per cent., and between these limits very varying amounts may be found. When the oil is in great preponderance often no other form of carbonaceous reserve material is present; in cases where but little oil occurs starch is usually found as well, as in so many of the Leguminosæ. The Cruciferæ as a group often contain oil in fairly large quantity. As a rule nitrogenous reserves in the shape of aleurone grains accompany the oil.

In other places than seeds large deposits of oil often occur, though their purpose is not so obvious. We have them in large amount in the pericarps of certain fruits, such as the olive; in the petals of many flowers, *e.g.*, Funkia and Ornithogalum, in the leaves of some of the Agaves, the roots of Oncidium, etc., etc. They can hardly be regarded in some cases as truly reserve materials, being perhaps more truly connected with the mechanisms of dispersion.

In places where their reserve character cannot be doubted, it is interesting to trace the changes that take place in them during the process of utilisation by the young plant. In all the cases we have so far investigated, but a slight change in the reserve material has been seen to be necessary in order that a nutritive pabulum may be prepared. The composition of an oil or fat is, however, much more complex, and its decomposition accordingly more intricate.

The earlier workers in this field, noticing the constant occurrence of starch in all germinating structures, seem to have been led to the view that this form is essential to nutrition, and that hence it must inevitably occur as a stage in the decomposition of all carbonaceous food material. Even in the digestion of oil this idea has been prominent. In 1859 Sachs (46) noticing the occurrence of starch in the young embyro of a fatty seed, suggested that the oil was in the first instance transformed into starch, though he admitted that it was very surprising. In 1861 Peters (47) endorsed the view of Sachs, publishing in support of it a number of analyses of the oily seed and seedling of the pumpkin during three stages of germination.

More reasonable views, however, soon superseded this; in 1865 Fleury (48) working on the castor-oil, rape, and almond seeds, pointed out a much more probable connection between oil and sugar, and showed that as the oil disappears in germination sugar is to be found, and that associated with the same events there is the coincident appearance of a non-volatile acid. Von Hellriegel (49) has argued in the same way with regard to rape seed, denying

the necessity of the occurrence of starch as an intermediate product. He takes the matter somewhat further by showing that the utilisation of oily reserves is attended by oxidative products, $Co_2$ being evolved during the whole period. Godlewski (50) shows that the absorption of oxygen is about equal to the evolution of $Co_2$ till the radicle protrudes from the seed, and that then it increases till it is in excess of the latter interchange, remaining so as long as there is fat or oil in the germinating seed.

These experiments point to the utilisation of the oily reserves being due to a series of changes much more complex than the simple hydrolysis of starch or splitting up of proteid.

The writer in 1890 published the results of some investigations into the germination of the castor-oil seed (51), in which he endeavoured to trace the course of events during the whole time of germination up to the time where the albumin was entirely used up. Starting from the results already described, and noting incidentally Schulzenberger's (52) suggestion of a fat splitting enzyme as probably present, the following course of events was found to be probable. The oil is by a ferment split up into fatty acid and glycerine; the ferment can be isolated from the germinating seeds and can be made to act upon an emulsion of the oil in an artificial digestion apparatus, giving sufficient quantity of both these products for satisfactory identification. The glycerine cannot be detected in the cells of the tissue, disappearing as fast as formed. The fatty acid can be readily extracted, being taken up freely by dilute alkalis. The quantity increases up to about the fourth or fifth day, then gradually diminishes as the antecedent oil gets less and less in amount till they both disappear, the fatty acid being however a little longer in evidence.

At this point enzyme action stops; the decompositions initiated by it, however, go on. The disappearance of the glycerine is attended by a constant appearance of sugar, and it is probable that the latter is the form in which this moiety of the oil is made available for nutrition. Many observers have shown the close relations between glycerine

and sugar; from our own standpoint perhaps the most stress may be laid on Brown and Morris's (35) experiments on feeding barley embryoes; one material which led to the formation of carbo-hydrate in their tissues being glycerine. The fatty acid at the same time undergoes a decomposition into simpler forms which are capable of dialysis. An acid of this kind can be prepared from the germinating seeds which will yield characteristic crystals when an ethereal solution of it is slowly evaporated. The changes leading to the formation of these bodies are no doubt oxidative, and are carried out by the direct action of the protoplasm of the cells. This is supported by the observation of Godlewski already quoted, that the absorption of oxygen by the seeds is greater than the output of $Co_2$ during the time at which these metabolic changes are most vigorous, and to the experiments of Hazura and Grüssner (53) and of Krafft (54) who have shown separately that different fatty acids do produce such crystalline products when gently oxidised.

These conclusions are in the main confirmed by the researches of Du Sablon (55) upon the same seed. This writer finds that the proportion of oil in the dried seed amounts in some cases to 69 per cent., and that on germination this diminishes, the amount being only about 10 per cent. when the radicle is 12 cm. long. He says that in his experiments the fatty acid increases irregularly during germination, and is about 0·5 per cent. of the dry weight at its conclusion. He failed to identify the glycerine with certainty, but found a large formation of sugar as the process proceeds.

The deposition of the fatty matter in the cells of the seeds or other parts has not been so fully worked out as its disappearance. There is reason to believe that it is the converse of the latter; that the various products are taken to the cells in the forms of the dialysable bodies described, rather than that they are completely formed where the fat is deposited.

The intervention of protoplasms is necessary for the deposition of the fat or oil, but that intervention seems

to be rather for the purpose of effecting the ultimate, than the initial, changes. The completed product can be sometimes detected in the protoplasm in the forms of small droplets, often no larger than mere points or specks which are stained brownish-black by osmic acid. The process seems to correspond very closely to the action of the leucoplastid in forming starch from the sugar supplied to it.

In certain plants peculiar corpuscles or plastids have been found which have been thought to play a part in the deposition of oil exactly similar to that of the leucoplastid in the case of starch. These bodies have been called *elaioplasts* by their discoverer, Von Wakker (56). They have not been seen in reservoirs where oil is present in great quantity, but chiefly in leaves of various kinds. Von Wakker found them in the epidermis of young leaves of Vanilla; Zimmermann (57) has described them as occurring in the perianth of Ornithogalum and Funkia, and the leaves of a species of Agave and in the root of Oncidium. They are of various shapes, sometimes round or oval, sometimes very irregular, generally lying near the nucleus in the cell. Each consists of a stroma in the meshes of which the oil is slowly formed.

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# THE SPACE RELATIONS OF ATOMS.

THE theory that matter is composed of atoms is not older than the theory that the nature of the matter depends on the arrangement of the atoms. Both these doctrines are said to have originated together about twenty-three centuries ago; and their association was inevitable since the ancient atomic theories assumed the substance of all atoms to be alike; that matter is not all alike could therefore be explained only by supposing the atoms to differ in their space relations. For two thousand years these notions endured. They were elaborated, but essentially unchanged. "God made the atoms," says Sir Isaac Newton, "of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which He formed them."

Later Swedenborg enters into elaborate calculations concerning the sizes, shapes, and proportion to space. He holds the atom to be a geometrical point, and to be the same for all matter. And he sets forth a sort of "genesis of the elements," in which the evolution of six kinds of particles is traced from the geometrical point, through the smaller particles of gravitation, magnetism, and ether, to the larger forms constituting air, aqueous vapour and water. All the particles are hollow spheres, and all are of the same nature; the difference is only in size. The properties of bodies depend entirely on the size and arrangement of their component spheres. In water the arrangement is simplest. The centres of four large spheres form a square, and eight of them make a cube. This is confirmed by forty-seven observations and experiments on water. Further, each of the large spheres of water is surrounded by the next smaller spheres, these again by the next smaller, and so on through the series of six down to the mathematical point.

From this arrangement the arrangement of other bodies is deduced. The shape of the particles of salt, for example, follows from the simple fact that at the bottom of the sea

the smaller globules of water disintegrate and fill up the interstices between the larger globules, thus forming the salt of the sea. The particles of salt have therefore exactly the shape of the interstices between the spheres of water; *i.e.*, they are shaped like "cubes" and tetrahedra, both with curved sides. This is confirmed by fifty experiments on salt. For example, the corners or points of the tetrahedra are nothing but the acids of the salt, and if the points be broken off by heat the remainder is insipid and without acidity.

This work was published by Swedenborg in 1721. Again, as late as 1777, we find Wenzel proving that the properties of bodies depend on the configuration of their smallest particles. A little later, however, arose the doctrine that difference in the properties of matter is due to essential differences among atoms. Atoms of elements were opposed to the old atoms of matter. It is evident that with the growth of this doctrine the necessity for attributing importance to the space relations of atoms disappeared. For the first time a state of atomic chaos became an *à priori* possibility. Difference in properties implied now difference in the nature, not in the arrangement of atoms. In particular the question of the relative weights of the atoms came to the front, and *pari passu* the question of their relative sizes and positions passed to the rear. It soon came to be admitted that, in general, atoms exist only in groups (molecules), but it remained an open question whether or not there was any definite arrangement within these groups; whether each atom had a fixed position (or a fixed orbit), or whether unstable equilibrium, a chaotic state of ever-shifting atoms, prevailed within the molecule.

The discovery of the first isomers, $(AgCNO)_n$, in 1823 by Liebig and Wöhler seemed calculated to call attention to this question. And presently Gay-Lussac suggested that difference of properties in bodies containing the same atoms and the same number[1] of each was due to

[1] That the atoms composing Wöhler's cyanate and Liebig's fulminate of silver were not present in the same number in the respective molecules, but only in the same proportion, was not immediately recognised.

a difference in the arrangement of the atoms. But it does not seem clear that Gay-Lussac referred to anything more than what we should now call a difference of linking or grouping of the atoms. Thus in a compound $(RCNO)_n$, there may be special linking between R and N, and C and O, or between R and O, and N and C, and in either case the atoms may have the same position, thus :—

| | | | |
|---|---|---|---|
| R | O | R | O |
| N | C | N | C |

The dotted lines indicate the division into groups. This isomerism is realised in the case where R isan alkyl (methyl or ethyl). For in the decomposition products of an isocyanurate the alkyl appears linked with N, and C with O, whereas when the cyanurate is broken up by the same reagents the alkyl clings persistently to O, C retaining N. Thus the groups pass unchanged from molecule to molecule.

And here we come upon a class of facts which led chemists to suspect, or perhaps unconsciously to assume, the definite as opposed to the chaotic state for the atoms in a molecule. It was the persistence of types which brought about this result,—the habit which bodies have of preserving, despite substitutions, their properties and their chemical functions. "Thus," says Dumas, "in a building, stone is replaced by stone but the form is preserved." Here the term "building" implies fixity of the relative positions of the atoms. The fact that aromatic radicals, as $C_6 H_5$, and $C_{10} H_7$, introduced into fatty molecules preserve their nature, that propyl remains different from isopropyl, shows that there are certain groups of atoms which are separated from the rest, not chaotically jumbled with them. But, within these groups, is the position of the atoms, or of their orbits, a constant or an ever-changing one? It remained for Biot and Pasteur to supply the answer to this question.

Biot showed as early as 1817 that a substance (oil of turpentine) may even in the form of vapour rotate the plane of polarised light, and concluded that this power depends on the internal structure of the molecule.

Pasteur observed that when a body is optically active in solution, its crystals possess a hemihedry corresponding to the activity (right or left-handed) of the solution, and he deduced the theory of the asymmetric structure of the molecules of bodies active in solution. We cannot admit that the rotatory power is due to the particular mode of aggregation of the chemical molecules forming the crystal molecule, for it would be necessary to admit also that this association persists in solutions and in vapours, whereas determinations of freezing-points and of vapour-densities show that the crystal molecule is dissociated in these conditions. Pasteur concluded that "the right- and left-handed isomers are like right- and left-handed spirals or staircases" in their atomic arrangement. As dissymmetry is impossible without internal stability, we have here the fundamental principle of stereochemistry.

Now Sarrau has given mathematical proof that when in a body through which polarised light is passing there is dissymmetry, it must betray itself by rotation of the plane of the light. This being so we may proceed to consider in what cases dissymmetry would be expected to occur, and we may then compare the results with the facts by testing the substances in question for optical activity.

Evidently every arrangement of four or more different bodies lacks symmetry, unless it is a plane arrangement. In general, then, every molecule in which a radical A is joined to three or more radicals, R′ R″ R‴, etc., differing from it and from one another will be asymmetric. But there will be exceptions, (1) when the radicals are not relatively fixed; (2) when the arrangement is plane; (3) when one radical, as R‴, is a duplicate of the rest of the molecule, so that a symmetrical molecule A R′ R″ R″ R′ A results.

(1) *Molecules internally unstable.* An exception of this class occurs according to Le Bel (*Revue Scientifique*, xxviii., 609), whenever the radical A is not a simple radical. That is to say, the link between two groups is movable so that indirectly connected atoms have no definite orientation. For consider ethane, $C_2 H_6$; the simplest arrangement of the

hydrogen atoms is at the corners of two parallel equilateral triangles, as in the prism formula for benzene; on substituting two atoms of chlorine for two atoms of hydrogen, we should have, then, three isomers as in the case of benzene; but there are only two. More complicated arrangements would give a still wider divergence. Therefore no fixed arrangement of the hydrogen atoms exists, but they are constantly changing places.

This argument, however, will not hold; for as Le Bel has himself urged, the number of positions of equilibrium of a molecule depends on the particular properties of the elements composing it, and not at all on the positions which the replaced atoms occupied before replacement. In other words, there are two positions of equilibrium for the chlorine atoms in $C_2 H_4 Cl_2$, and when this compound is formed from $C_2 H_4 H' H''$, the atoms will re-arrange themselves until the chlorine atoms reach one or other of their two possible positions, whether these were previously occupied by the displaced hydrogen atoms H′ H″ or not. There is then no theoretical ground for opposing Le Bel's earlier view that A may be any radical, simple or complex.

Indeed it seems probable that we must look in the opposite direction for exceptions of the first class. It is when the radicals R′ R″, etc., are small and light, that we should expect the mobility of the chaotic state. In particular, the hydrogen atom would be suspected of destroying the stability necessary for asymmetry. A notable instance is afforded by the tri-substituted ammonium chloride (R′ R″ R‴ $R^{iv}$ $R^{v}$ = Me Et Propyl H and Cl), which Le Bel found to be inactive, while on replacing the last hydrogen by a compound radical (isobutyl), activity resulted. Again, the inactivity of bromnitro-ethane, $CHBrNO_2CH_3$ has suggested a desmotropic action of the hydrogen atom as an explanation. This cannot be accepted in face of the fact that such substances as methyl-ethyl-carbinol, $CH \cdot CH_3 \cdot C_2H_5 \cdot OH$, propylene-glycol, $CH \cdot CH_3 \cdot CH_2OH \cdot OH$, and lactic acid, $CH \cdot CH_3 \cdot OH \cdot COOH$, are active. At the same time simplicity of structure certainly favours mobility, as witnessed by the fact that asymmetry has never been

detected in substances containing less than two complex radicals attached to A, though according to the general rule many such substances should be asymmetrical. In other words an asymmetric carbon atom[1] has never been found sufficient to cause activity unless joined to at least two other carbon atoms.

(2) *Two-dimensional molecules.* Ethylene derivatives were the first polyatomic compounds shown to have a plane arrangement. The proof is due to Le Bel, who relied on the fact that when we add R‴ to each carbon atom in the two isomeric substances having the formula CR′R″ CR′R″, the resulting CR′R″R‴ CR′R″R‴ is, according to the isomer taken, either inactive, or a mixture of two isomers of equal and opposite activity in equal proportions. For the formation of the active isomers in equal quantity can only result from the fact that 2 R‴ is attached to half the CR′R″ CR′R″ molecules on one side and to half on the other, in corresponding positions. But in order that this may be the case the molecules must present, when approached by the two R‴ groups in any direction, an atomic arrangement exactly similar to that presented when the approach is made in the opposite direction. Now there are only two positions which possess such symmetry: (1) The R′R″ groups are in one plane, and the carbon atoms occupy corresponding positions one on each side of this plane; (2) the whole arrangement is plane.

But to the first kind of molecule the R‴ groups could attach themselves symmetrically only in the plane of the R′R″ groups and the result would be an inactive substance only. Therefore the plane arrangement is the only one admissible. That it satisfies all requirements is readily shown.

We then have for the two original isomers the two formulæ

$$\text{I.}\quad \begin{matrix} R' & & R' \\ & C\ \ C & \\ R'' & & R'' \end{matrix} \qquad\qquad \text{II.}\quad \begin{matrix} R' & & R'' \\ & C\ \ C & \\ R'' & & R' \end{matrix}$$

[1] A carbon atom united to four, or a nitrogen atom united to five different radicals is called an asymmetric atom.

In I. like groups are on the same side, in II. on the opposite sides of the molecule ("cis-trans" isomerism, also called, in a special sense, "geometrical" isomerism).

Formula I. yields $R'''\begin{matrix} R' \\ C \\ R'' \end{matrix}\!\!\begin{matrix} C \\ \\ R'' \end{matrix}\begin{matrix} R' \\ \\ R''' \end{matrix}$ ($\alpha$)

and formula II. yields $R'''\begin{matrix} R' \\ C \\ R'' \end{matrix}\!\!\begin{matrix} C \\ \\ R'' \end{matrix}\begin{matrix} R' \\ \\ R''' \end{matrix}$ ($\beta$)

In $\alpha$ each $CR'R''R'''$ group is the mirrored image of the other, and this will be the case whether the $R'''$ groups are attached above or below the plane of the paper. In $\beta$ each $CR'R''R'''$ group can be superposed on the other, hence each group possesses activity of the same sign and the molecule is doubly active; but if the $R'''$ groups instead of attaching themselves (say) above the plane of the paper, attach themselves below, we have another body formed. In this, also, the $CR'R''R'''$ groups are superposable, and the molecule is doubly active; but its activity is directly opposed to that of its isomer, because the order of the $R'R''R'''$ groups has been transposed. And since the $R'''$ groups will act as often on one side of the molecule as on the other, the isomers will be produced in equal quantities.

Such a case is presented by the formation of mesotartaric acid on oxidising maleïc acid, and of racemic acid on applying the same oxidising agents to fumaric acid. Hence the observed results compel us to accept a plane arrangement in this case, and we may fairly assume that the same arrangement holds for other derivatives of ethylene. In complete accordance with this we find these substances uniformly inactive even when possessing the formula $A\ R'\ R''\ R'''\ R^{iv}$ ($A = C_2$). An exception was announced in the form of an active citraconic acid $CH \cdot COOH \cdot C \cdot CH_3 \cdot COOH$, but Le Bel now finds that the active substance he obtained by the action of microbes on the inactive acid was methyl-malic acid.

Again there is reason to believe that, as a rule, benzene derivatives possess plane molecules. Chemically, there is

little to be said against such an arrangement, and for the carbon atoms at least it is rendered probable by the fact that it obtains in the case of the allied hexamethylene (see below). On the physical side there is the fact that no optically active substituted benzene has been discovered, although derivatives lacking symmetry have been specially examined by Le Bel to this end. All these substances then, except such as possess an asymmetric *atom*, may be classed as probably two-dimensional.

There is another class of bodies for which a plane arrangement is accepted as the cause of inactivity, namely the substituted ammonias, $NR'R''R'''$. *A priori* these might possess either a two or a three-dimensional configuration, but as they are uniformly inactive, and as the complex nature of the radicals attached to nitrogen in the compounds tested for optical activity by Kraft, Behrend, Ladenburg and others, makes it improbable that their inactivity was due to internal instability, these substances also must rank among the exceptions of the second class.

(3) *Three-dimensional molecules containing more than one $AR'R''R'''$ group.* Besides meso-tartaric acid already mentioned, we may instance hydrobenzoïn $\begin{matrix} C\text{HOH}C_6H_5 \\ C\text{HOH}C_6H_5 \end{matrix}$ and trioxyglutaric acid $\begin{matrix} C\text{HOH}CO_2H \\ \text{CHOH} \\ C\text{HOH}CO_2H \end{matrix}$ (the asymmetric atoms are italicised).

Both these substances are inactive owing to internal compensation. The last case is complicated by the existence of an isomerism akin to the cis-trans isomerism already mentioned, so that here we have two substances which cannot be rendered active, corresponding to the formulæ

$$\begin{matrix} R'' \\ R'\,C\,R''' \\ X\,C\,Y \\ R'\,C\,R''' \\ R'' \end{matrix} \quad \text{and} \quad \begin{matrix} R'' \\ R'\,C\,R''' \\ Y\,C\,X \\ R'\,C\,R''' \\ R'' \end{matrix}$$

When there are four similar asymmetric groups we

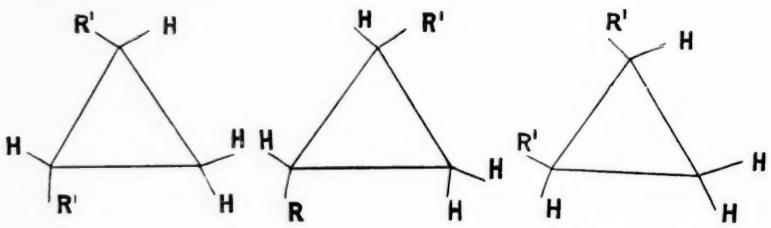
again have two inactive isomers. Representing the direction of the rotation for each group by *R* for right-handed and *L* for left-handed, these are

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | R | | L | | R | | L |
| I. | R | identical with | L | and II. | L | identical with | R |
| | L | | R | | L | | R |
| | L | | R | | R | | L |

Thus for $CO_2H(CHOH)_4CO_2H$ we have besides active isomers the bodies mucic and allomucic acid (Fischer, *Ber. d. chem. Ges.* xxv., 1247 and xxiv., 2136), both of which cannot be rendered active.

In short, wherever similar asymmetric groups are opposed to one another we have at least one permanently inactive substance.

We have now exhausted the cases which may be supposed to come within one or other of our three classes of exceptions; but there still remains a host of substances unaccounted for — substances possessing the formula $AR'R''R'''$ and yet inactive. In the first place, among all the great number of known ring-compounds, none except such as possess an asymmetric carbon-atom is known to possess optical activity. Yet the evidence goes to show that, unlike benzene, many of these compounds have three-dimensional molecules. This follows from Buchner's observations on the derivatives of trimethylene. In this, the simplest of the ring-compounds, the carbons of the ring must lie in one plane, because there are only three of them. Now Buchner (*Ann. Chem.* (Liebig), cclxxxiv., 197-226) has shown that the radicals attached to the carbon-atoms do not lie in this plane, for otherwise there must be three isomeric disubstituted tri-methylenes, $CH_2 \cdot CHR' \cdot CHR'$, having the formulæ :—



But Buchner has prepared the dicarboxyl derivatives according to all the known methods, and has found it impossible to detect more than two isomers. This is the number arrived at by arranging the H and R′ atoms in two planes one on each side of the ring and parallel with it; we may then have either one R′ on one side of the ring and one on the other, or both on the same side, (cis-trans isomerism); in no other way can the number of theoretical isomers be limited to two. We must therefore accept a three-dimensional arrangement for the trimethylene derivatives, especially as the properties of Buchner's derivatives are such as the "cis-trans" formulæ would lead us to expect. And from the great analogy between the trimethylene and the hexamethylene dicarboxylic acids, which also exhibit the maleïcfumaric or cis-trans isomerism, we may extend this arrangement to hexamethylene derivatives. Now these conclusions derive no support whatever from the optical evidence. It must be remembered, however, that this evidence is purely negative, and that, with the exception of benzene-derivatives, ring-compounds have not been thoroughly investigated as to their optical activity. In these circumstances it is specially interesting to consider the case of limonene.

This substance has a mixed methene-methine ring; it is undoubtedly active, and it has been supposed to contain an asymmetric carbon atom. But, according to the recent investigation of its constitution by Baeyer (*Ber.* xxvii., 439, 450), it contains no such atom. So that if Baeyer's limonene formula hold its own against its various rivals, we have here the first exception to the empirical law that an active molecule must contain an asymmetric atom. It is certainly to be hoped that further investigation will either supply the theoretical basis of this law, or bring the optical into accord with the chemical evidence, and with the theory of Sarrau.

It is possible, however, that the inactivity of asymmetric ring-compounds is only apparent. For even compounds containing an asymmetric atom are often apparently inactive, because like racemic acid they are composed of right- and left-handed molecules in equal numbers. Such inactive

molecular aggregates always result from the artificial formation of active molecules. In fact in the molecule $C(R')_2R''R'''$ the forces acting between one R′ radical and the remaining radicals are the same as those between the other R′ and the remaining radicals; hence each R′ must be at the same distance from each of the radicals $CR''R'''$; that is, they are on a line drawn at right-angles to the plane of $CR''R'''$ (or to the line $CR''R'''$ if this is a straight line), and at equal distances on each side of that plane (or line). It follows that when an R′ group is replaced by $R^{iv}$, the exchange will be effected indifferently on either side of the molecule, so that in the enormous number of exchanges occurring in any chemical reaction, there will be as many molecules attacked on one side as on the other, and we shall have as many $CR'R^{iv}R''R'''$ molecules as $CR^{iv}R'R''R'''$ molecules. The formation of equal quantities of right- and left-handed molecules is therefore in complete accord with the symmetrical configuration of $C(R')_2R''R'''$. Given the symmetry the equality in the quantities follows, and *vice versâ*. From this symmetry it follows further that substances of the formula $C(R')_2R''R'''$ will be inactive. This is invariably the case. If in the active body $C \cdot CH_3 \cdot CH_2I \cdot H \cdot C_2H_5$ we do but substitute H for I, forming $C \cdot (CH_3)_2 \cdot H \cdot C_2H_5$, inactivity results. This is another remarkable confirmation of the symmetry of the molecule $C(R')_2R''R'''$. Moreover it goes to show that this molecule is three-dimensional, since it is very unlikely that the simple substitution of H for I should so profoundly modify the large molecule of amyl iodide as to reduce it from three dimensions to two.

The results we have thus far attained with regard to asymmetry may be briefly summarised thus:—

General law: Asymmetric molecules are such as contain $AR'R''R'''$, etc.

| | | | |
|---|---|---|---|
| Exceptions. | Theory. | I. | Chaotic molecules. |
| | | II. | Plane molecules. |
| | | III. | Self-compensating molecules. |
| Exceptions. | Found. | I. | II. and III. as above. |
| | | IV. | All substances (except perhaps limonene) in which A is not a single atom. |

Now as the only asymmetric atoms which have been studied are C and N, and as $N'''$ derivatives are included in Exceptions II., we find that Exception IV., amounts to the statement of the empirical law mentioned above, that active bodies must contain an asymmetric atom, with the addition that this atom must be C or $N^{v}$; it would seem, then, that instead of saying asymmetric molecules are such as contain $AR'R''R'''$, etc., we must say asymmetric molecules are such as contain $CR'R''R'''R^{iv}$ or $NR'R''R'''R^{iv}R^{v}$. This remains to be proved; but while insisting that the presence of an asymmetric atom may not be *necessary*, it is fair to emphasise the fact that, with the few exceptions of Class I., it is *sufficient* to cause optical activity.

This statement is at once demanded by theory and warranted by observation. The number of derivatives of $N^{v}$ which have been examined is not large enough to afford a generalisation. It must suffice to say that activity undoubtedly exists among asymmetric bodies of this class.

With asymmetric carbon compounds, however, the case is very different. The proof of their activity has indeed been complicated by the fact already mentioned, that active molecules tend to form inactive aggregates. But this difficulty, while it has delayed, has also confirmed the triumph of the theory. The first method of splitting up the inactive aggregate into active molecules (*dédoublement*, *Activirung*, doubling), was discovered as long ago as 1848 by Pasteur, who during the succeeding ten years originated the other methods also. They are:—

I. Division by combination with other active molecules. Thus by neutralising a solution of racemic acid with the active alkaloid cinchonine, Pasteur was able to crystallise out the salt of left-handed tartaric acid before its isomer, and Ladenburg obtained coniine in active form by combining it with active tartaric acid.

This method, however, is applicable only to acids and bases.

II. Division by the action of living organisms. Since these are largely composed of active bodies (albuminoids, sugars), this method may be regarded as a special develop-

ment of the preceding one. In nature plants form from their inactive food (carbonic acid, water, ammonia, etc.) all kinds of active substances as terpenes, carbohydrates, alkaloids; and in the animal organism it has been shown that inactive bromobenzene is converted into active bromphenylmercapturic acid (Baumann and Preusse, *Ztschr. f. physiol. Chem.* v., 309, *Ber.* xv., 1731). In the laboratory, micro-organisms are employed. Thus Le Bel obtained right-handed amyl-alcohol, $CH_3C_2H_5CHCH_2OH$, by means of penicillium, and Tutton (*Chem. Soc. J.*, 1891, 233) formed left-handed glyceric acid, $CH_2OHCHOHCOOH$, by means of bacillus ethaceticus.

The disadvantage of this method is that one isomer is lost.

III. Spontaneous conversion. On crystallising a solution of sodium ammonium racemate, Pasteur found the two tartrates separate. This result depends on the temperature employed. The method has been recently used by Zelinsky (*Ber. d. Chem. Ges.*, xxiv., 4014).

By the employment of one or other of these three methods, activity has been demonstrated in almost all the molecules containing an asymmetric carbon atom, which have been tested. There are still a few exceptions outstanding, in particular certain chlorine and bromine derivatives of succinic and acetic acids. The explanation of these cases is, that when halogens are united with the asymmetric carbon atom racemisation very readily results. The stability of the right- and left-handed isomers is slight; the one may be converted into the other by heat and even by catalytic action, as when tartaric is converted into racemic acid by oxide of iron or by alumina. Now when isomerisation takes place inactivity must result. For owing to the complete mechanical symmetry of the two systems of like atoms, the tendency to conversion will be the same in both, and there will always be more converted of that isomer which is in excess until equal quantities of both are present (Van't Hoff, *Atome im Raume*, 1894, p. 32).

When, therefore, we find bromo-succinic acid, made from active malic acid, to be inactive, while chloro-succinic acid

from the same source is active, we can only conclude that the former acid consists, not of inactive molecules, but of right- and left-handed molecules in equal quantity;[1] and if the temperature of racemisation[2] lies below the ordinary temperature, the difficulty of separating the active isomers is accounted for. This explanation may apply also to those asymmetric molecules previously spoken of as possibly chaotic.

Apart from these "chaotic" molecules, we cannot admit a single valid exception to the law of the sufficiency of the asymmetric carbon-atom to cause optical activity.

So far we have mainly followed Le Bel, who bases his conclusions on purely geometrical considerations, resting none of them on any doctrine as to valence or its cause. And the scope of the results arrived at, embracing as they do the theories of optical activity, of geometrical isomerism, and, to a certain extent, of ring-structure, shows that stereochemistry may advance in complete independence of any particular theory of valence.

In fact the question as to what are the places of the atoms may be treated quite apart from the question as to what holds them in their places; and to ask chemists to answer the second question before they have informed themselves as to the first, would be equivalent to asking astronomers what caused the arrangement of the planets before they knew what that arrangement was. The discovery of the chemical law of gravitation may be the aim, but it is not the starting-point of stereochemistry. At the same

[1] The proof of this has been given by Walden in a paper (*Ber.*, xxviii., 1287) published while the above was passing through the press. By working at moderate temperatures, Walden has succeeded in preparing not only active bromo-succinic acid, and derivatives, but many other active halogen-acids, including α-phenyl-chloracetic acid, and α-chloro- and α-bromo-propionic acids. He concludes that an asymmetric carbon-atom always causes optical activity whatever the nature of the attached radicals. But so long as no active substance is known containing less than three carbon-atoms, this statement is subject to the limitation imposed in the text, concerning the molecules provisionally called chaotic.

[2] This term is used to indicate the formation of the inactive aggregate from two isomers of opposite activity.

time, none can deny the services which theories based on the property of valence have rendered to stereochemistry, especially in the hands of van't Hoff, whose views we have presently to consider. If we have thus far postponed an account of the work of the investigator who first opened up this branch of chemistry, it is because the theories involved have proved so fascinating that they have caused the general considerations underlying them, and more especially represented by Le Bel, to be very largely neglected; and also because a mind once occupied with a particular idea as to the direction of the valences of any atom in a molecule, finds it difficult to gain an unprejudiced view of the structure of the molecule as a whole.

ARNOLD EILOART.

(*To be continued.*)

# APPENDIX I.

## NOTICES OF BOOKS.

*The Physical Geology and Geography of Great Britain: a Manual of British Geology.* By the late Sir Andrew C. Ramsay, LL.D., F.R.S., etc. Sixth edition. Edited by Horace B. Woodward, F.G.S. London: Edward Stanford, 1894.

That the late Sir Andrew Ramsay exercised a great and important influence upon the progress of geological science during the last half-century is a fact concerning which there can be no question. The effects of his work, however, are seen in the improvements which he introduced into the methods of geological cartography, in the way in which he stimulated research among his pupils, and in the public interest which he aroused by his bold and original speculations, rather than in any published work that he has left behind him. But there is one book of Ramsay's—that of which a new edition has now appeared—which serves to reveal the greatest of our field geologists at his best. Full of accurate observations and suggestive theories, this book is calculated to inspire that love of an out-of-door life which was so characteristic of its author; while its literary charm makes itself felt by the most casual reader. No better book could be put into the hands of any person desirous of knowing something of the methods and results of modern geological science.

The volume originally consisted of six lectures delivered to an audience of working men; and it is doubtful if the expansion of the group of essays into a text-book for students did not somewhat detract from its value. The present editor has performed his task very admirably, only making such corrections and additions as were necessary to bring the book up to date. The map and illustrations are excellent, and add greatly to the value of the work.

*The Great Ice Age, and its Relation to the Antiquity of Man.* By James Geikie, LL.D., D.C.L., F.R.S., etc. Third edition. London: Edward Stanford, 1894.

Among the most devoted pupils and friends of Ramsay, the present Murchison Professor of Edinburgh, and the author of the next book on our list, has always loved to be counted. The *Great Ice Age* displays the same power of grouping facts, and the same boldness in theorising concerning them, which characterised Ramsay. The book has long been recognised as the ablest and most complete statement of the views of extreme glacialists; and its author has earned a reputation for industry in collecting and collating the observations of others, for ingenuity in dealing with the arguments of opponents, and for skill in presenting his own case.

Twenty years have now elapsed since the book was originally published, and it may be instructive to notice how far the speculations of its author have stood the test of time and the ordeal of criticism. In the first edition, the novel astronomical theory of the late Dr. Croll was very skilfully seized upon as the foundation of the book; but the criticism of Sir R. Ball and other mathematicians and physicists has led to the removal of the theory of recurrent glacial epochs to a subordinate place, the subject being now dealt with in a final chapter, which is almost of the nature of an appendix. The author says in his preface: "If I have read the geological evidence aright, the views supported by me will stand, even should Dr. Croll's theory eventually fail to find general acceptance".

In the first edition of the *Great Ice Age* the occurrence at high levels of sands and gravels containing marine shells in North Wales and the North of England was thought by the author to indicate a submergence of the country to the depth of over 2000 feet. In the present edition this great submergence is considered to be unproved; but, on the other hand, many smaller oscillations of level in different parts of the British Islands are invoked. In the first edition, two principal "interglacial periods" were supposed to have interrupted the great period of

cold which set in soon after the close of the Pliocene, and to have completely died out only a few thousands of years ago; but, in the present edition, at least four or five interglacial periods are thought necessary to explain the phenomena described.

A very valuable feature in the present edition is the sketch of the ice age in America which has been drawn up by Professor T. C. Chamberlin, who stands in much the same relation to glacial geology in the United States as Dr. James Geikie does in this country. The *Great Ice Age* has been largely rewritten, is well brought up to date, and is illustrated by a number of excellent maps and sketches.

*Papers and Notes on the Glacial Geology of Great Britain and Ireland.* By the late Henry Carvill Lewis, M.A., F.G.S. Edited from his unpublished MSS., with an introduction by Henry W. Crosskey, LL.D., F.G.S. London: Longmans & Co., 1894.

The late Professor H. C. Lewis was a man of rare scientific attainments, of remarkable industry, and of high promise, who devoted himself enthusiastically to the study of glacial phenomena on both sides of the Atlantic. Had his life been spared, there can be little doubt that his great powers and opportunities for research would have resulted in much new light being thrown on the very difficult problems which occupied his attention. In the book before us his widow has gathered together, with loving care, all that remains of the work of an able geologist and gifted writer. In his case, doubtless, further observations would have led to modifications of some of the views, and to corrections of some of the statements, contained in the present volume.

The introduction to the book, by the late Dr. Crosskey, whose loss geologists have now also to deplore, is a very able and judicious piece of work, and serves to make clear to the reader what were the ideas and suggestions upon the subject of glacial phenomena for which we are indebted to Carvill Lewis.

It may serve to illustrate the difficulty of explaining and of correlating with one another the very local and variable deposits known as "drifts," if we compare the general conclusions of the work we are now considering with those of the *Great Ice Age*. The latter work regards the boulder clay of England as having been accumulated under a vast ice-sheet; the former maintains that it was deposited in a set of extra morainic lakes. Dr. James Geikie, as we have seen, argues in favour of a complicated series of glacial and interglacial periods, while Professor Carvill Lewis insisted that there was no break whatever in the continuity of the glacial period.

*The Art of Projection.* By an Expert. London: E. A. Beckett, 1893.

The above work is a "Complete Magic Lantern Manual," and includes a "synopsis of the perfect manipulation of a triple lantern and effects".

It is evidently written by one who is practically acquainted with the subject, but the writer's style is so extraordinary that a feeling of irritation is constantly present whilst reading his descriptions. A single example will illustrate this: "The next operation after choosing the object we wish to show upon the screen, and here it is advised that unless some definite subject is taken for class demonstration, to manage all the slides in a series, so as to admit of the same power objective being used, it will save much time to the operator in changing both the object glass and substage condenser". The spelling also is very shaky, "loose" for "lose," "non compus mentus," etc. The book contains valuable hints, and it is a pity that it is spoiled by such defects.

*A Text-Book of Statics.* By William Briggs, M.A., LL.B., F.R.A.S., and G. B. Bryan, M.A. London: W. B. Clive.

This is one of the volumes in the "University Tutorial Series," and, like the rest of the books in the same series, affords a ready means of getting up the subject for an examination in a short time. For this purpose the work will doubtless prove of use.

*Cloudland.* By Rev. W. Clement Ley, M.A., F.R.Met.Soc. London: Edward Stanford, 1894.

This is a "Study on the Structure and Characters of Clouds," with special reference to their effects on the weather. It is well written, excellently illustrated with reproductions of water-colour drawings and photographs, and in every way deserves to be carefully studied by those who wish to be able to foretell the weather by observing the appearance of the sky. It is obviously the work of one who has devoted much time and thought to the subject.

*Principia Nova Astronomica.* By Henry Pratt, M.D. London: Williams & Norgate, 1894.

In this book the author puts forward a new theory, illustrated by figures and diagrams, of astronomical motion, and argues that the sun is revolving in commensurable orbit around a "Central Sun". He suggests as a possible answer to the question, "What is the meaning of stellar activity?" that it is an expression of the life of space, and that just as in organic beings a circulation of cells is carried on, so in space a circulation of the heavenly bodies occurs.

"Quis credet?" asks the author at the beginning of his book. "Quis credet?" the reader may well ask after a perusal of it.

*Elements of Bacteriology.* By Dr. S. L. Schenke. Translated from the German by W. R. Dawson, B.A., M.D., Dublin University. London: Longmans, Green & Co., 1893.

This is a translation of Professor Schenke's *Grundriss der Bakteriologie*, and the author states in the preface that particular attention has been paid to the elementary technique. The operations of staining and preparing tissues and fluids for examination are, as a rule, well described, but in the case of paraffin imbedding it would have been better to omit the description altogether than to give such an inadequate one as is here presented. The descriptions of individual organisms are generally well done, though somewhat short, and the figures are good, but would have been rendered more useful had they been provided with some indication of the amplifications used.

# APPENDIX II.

## ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN JANUARY, 1895.

Vol. xlix. No. 290. *American Journal of Science.* (February, 1895.)

*Derby, O. A.*, Constituents of the Cañon Diablo Meteorite (pp. 101-110). *Spenzer, J. G.*, β-Bromovalerianic Acid (pp. 110-112).

Vol. xvii. No. 2. *American Chemical Journal.* (February, 1895.)

*Gibbs, W.*, Researches on the Complex Inorganic Acids (pp. 73-91). *Kastle, J. H.*, and *Keiser, B. C.*, Diazobenzene Aniline Chloride (pp. 91-98). *Lengfeld, F.*, and *Stieglitz, J.*, On Imido-Ethers of Carbonic Acid (pp. 98-113). *Dains, F. B.*, and *Rothrock, J. R.*, On some Bromine Derivatives of Paraisobutyl Phenol (pp. 113-114). *Dains, F. B.*, On the Action of Acid Chlorides on the Methyl Ether of Paraisobutyl Phenol (pp. 114-116). *Kortright, F. L.*, The Effect of Hydrolysis upon Reaction-Velocities (pp. 116-122). *Wolff, J. A.*, On the Influence of Magnetism on Chemical Action (pp. 122-139).

Vol. xvii. No. 2. *The Journal of the American Chemical Society.* (Feb., 1895.)

*Venable, F. P.*, A Modified Arrangement of the Elements under the Natural Law (pp. 75-85). *De Roode, R.*, The Determination of Potash in Kainite (pp. 85-86). *De Roode, R.*, The Oxidation of Organic Matter and the Decomposition of Ammonium Salts by Aqua Regia, in Lieu of Ignition, in the Determination of Potash in Fertilisers (pp. 86-87). *Long, J. H.*, On Certain Phenomena Observed in the Precipitation of Antimony from Solutions of Potassium Antimonyl Tartrate (pp. 87-105). *Mabery, C. F.*, An Examination of the Atmosphere of a Large Manufacturing City (pp. 105-122). *Hoffmann, L. W.*, and *Hochstetter, R. W.*, A New Form of Water Oven and Still (pp. 122-125). *Campbell, E. D.*, and *Andrews, W. H.*, The Determination of Nickel in Nickel-Steel (pp. 125-129). *Noyes, W. A.*, and *Royse, J. S.*, The Volumetric Determination of Phosphorus in Steel and Cast Iron (pp. 129-137). *Norton, T. H.*, The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagration (pp. 137-148). *Snyder, H.*, The Action of Organic and Mineral Acids upon Soils (pp. 148-151).

Vol. xx. No. 227. *The Analyst.* (February, 1895.)

*White, J.*, Note on the Use of Maize as an Adulterant of Oatmeal (pp. 30-32). *Kitto, B.*, Note on a Sample of Supposed Lard (pp. 32-33). *Bodmer, R.*, Note on a Sample of Larderine (pp. 33-35). *Aitken, A. P.*, The Determination of Woody Fibre in Fodders (pp. 35-37).

Vol. lxvii. No. 387. *Journal of the Chemical Society.* (February, 1895.)

*Linder, S. E.*, and *Picton, H.*, Solution and Pseudo-Solution. Part II. Some Physical Properties of Arsenious Sulphide and other Solutions (pp. 63-74). *Stern, A. L.*, Contributions to the Chemistry of Cellulose. I. Cellulose-Sulphuric Acid and the Products of its Hydrolysis (pp. 74-90). *Muir, P. M. M.*, and *Eagles, E. M.*, Note on the Interaction of Bismuth Haloïd Compounds and Hydrogen Sulphide (pp. 90-94). *Dunstan, W. R.*, and *Garnett, H.*, The Constituents of *Piper ovatum* (pp. 94-100). *Dunstan, W. R.*, and *Garnett, H.*, Note on the Active Constituent of the Pellitory of Medicine (pp. 100-102). *Henderson, G. G.*, and *Ewing, A. R.*, Action of Certain Acidic Oxides on Salts of Hydroxyacids. Part I. Metallic Tartrarsenites (pp. 102-108). *Bone, W. A.*, and *Perkin, jun., W. H.*, The Condensation of Ethylic Trimethylenedicarboxylate with Ethylic Malonate (pp. 108-119). *Goodwin, W.*, and *Perkin, jun., W. H.*, *cis-* and *trans-*Hexahydro-orthotoluic Acids (pp. 119-128). *Collie, J. N.*, A New Form of Barometer (pp. 128-132). *Japp, F. R.*, and *Davidson, W. B.*, Condensation of Benzile with Ethylic Malonate (pp. 132-139). *Kipping, F. S.*, Stereoisomeric $\alpha\alpha^1$-Dimethylpimelic Acids (pp. 139-155). *Ince, W. H.*, Preparation of Adipic Acid and some of its Derivatives (pp. 155-160). *Heycock, C. T.*, and *Neville, F. H.*, On the Determination of High Temperatures

by Means of Platinum-Resistance Pyrometer (pp. 160-199). *Maclaurin, J. S.*, Action of Potassium Cyanide Solutions on New Zealand Gold and Silver (pp. 199-212).

Vol. xxxix. No. 237. *Philosophical Magazine and Journal of Science.* (February, 1895.)

*Olszewski, C.*, On the Liquefaction of Gases (pp. 188-213).

Vol. lvii. No. 341. *Proceedings of the Royal Society.* (25th Jan., 1895.)

*Ewan, T.*, On the Absorption Spectra of Dilute Solutions (pp. 117-161).

Tome iv. *Annales de Chimie et de Physique.* (Février, 1895.)

*Berthelot*, Sur les relations qui existent entre les proportions multiple des composés chemiques et la chaleur dégagée dans leur formation (pp. 145-213). *Lescoeur, H.*, Recherches sur la dissociation des hydrates salins et des composés anologues (pp. 213-235). *Freundler, P.*, Sur la variation du pouvoir rotatoire dans la série tartrique et le pouvoir rotatoire des corps dissons (pp. 235-271). *Auguste*, et *Lumière, L.*, Sur les développateurs organiques de l'image latente photographique (pp. 271-288).

Tome xiii. No. 2. *Bulletin de la Société Chimique de Paris.* (20th Jan., 1895.)

*Berlemont*, Soupape de sûreté pour trompe à eau (pp. 33-34). *Guye, P. A.*, Détermination du poids moléculaires des liquides; application aux hydrocarburés (pp. 34-38). *Varet, R.*, Recherches sur la dissociation par l'eau du sulfate et de l'azotate mercuriques (pp. 38-41). *Schlumberger, E.*, Sur quelques composés aluminiques (pp. 41-65). *Varet, R.*, Recherches sur les azotates mercuriques (pp. 65-68). *Thomas-Mamert, R.*, Sur le 3-aminoanticronate d'éthyle (3-iminobutanvate d'éthyle) et ses homologues (pp. 68-73). *Delépine*, Combinaison de l'hexaméthylène-amine avec l'azotate, le chlorure et le carbonate d'argent (pp. 73-77). *Bertrand, G.*, et *Mallèrve, A.*, Recherches sur la pectase et sur la fermentation pectique (pp. 77-82). *Barthe, L.*, Sur le dosage volumétrique des sels minéraux de zinc (pp. 82-85). *Horsin-Déon, P.*, État actuel de la sucrerie (pp. 85-93).

Tomes xiii.-xiv. No. 3. (5th February, 1895.)

*Lespieau, R.*, Essai de nomenclature de quelques isomères stéréochimiques (pp. 105-108). *Monnet, P.*, Appareil de laboratoire pour distillations fractionnées (pp. 108-114). *Gantz*, Sur les fluorures acides de potassium et d'argent (pp. 114-115). *Ferrand, L.*, Sur quelques thiohypophosphates (pp. 115-117). *Brochet, A.*, Action du chlore sur les alcools secondaires (pp. 117-121). *Fournier, H.*, Sur quelques glycérines dérivées d'alcools allylés secondaires (pp. 121-125). *Chancel, F.*, Sur la nitrosopropylacétamide (pp. 125-126). *Brunner, H.*, et *Chuard, E.*, Sur la présence de l'acide glyoxylique dans les fruits verts (pp. 126-128). *Delépine*, Recherches sur la constitution de l'hexamèthylène-amine (pp. 128-135). *Delépine*, Hydrogénation de l'hexaméthylène-amine; formation de triméthylamine (pp. 135-140). *Reychler, A.*, L'essence de Cananga (pp. 140-142). *Lescoeur, H.*, Recherche et séparation de l'acide chlorhydrique libre et des chlorures. Application à l'analyse du suc gastrique (pp. 142-154). *Arth, G.*, Sur l'utilisation des gaz de hauts fourneaux (pp. 154-155).

Tome cxx. No. 1. *Comptes Rendus hebdomadaires de l'Académie des Sciences.* (7th January, 1895.)

*Pictet, R.*, Utilisation de la temperature du point critique des liquides pour la constalation de leur pureté (pp. 43-46). *Villiers, A.*, Sur la séparation qualitative du nickel et du cobalt (pp. 46-47). *Moissan, H.*, Préparations au four électrique, de graphites foisonnant (pp. 17-19).

Tome cxx. No. 2. (14th January, 1895.)

*Pictet, R.*, Recherches expérimentale sur le point critique des liquides tenant en solution des corps solides (pp. 64-67). *Ditte, A.*, Sur quelques propriétès du sulfure d'argent (pp. 91-94). *Vigouroux*, Sur la préparation du selicuin amorphe (pp. 94-97). *Villiers, A.*, Sur l'état protomorphique. Sulfures de zinc et de manganèse (pp. 97-100). *Oechsner de Coninck*, Sur quelques réactions sensibles des acides amidobenzoïques (pp. 100-101). *Colson, A.*, Sur une classe de nitrites (pp. 101-105). *Camber, A.*, et *Brochet, A.*, Sur la constitution de l'hexaméthyl ènetétramine (pp. 105-107). *Henry, L.*, Sur le méthylal éthylénique (pp. 107-110).

Tome cxx. No. 3. (21st January, 1895.)

*Moissan, H.*, et *Charpy, G.*, Sur l'acier au bore (pp. 130-132). *Villiers, A.*, Influence de la température sur la transformation du sulfure du zinc amorphe (pp. 149-152). *Delépine*, Insuffisance de la méthode de Kjeldahl pour doser l'azote dans les chloroplatinates (pp. 152-153). *Hanriot*, Sur l'arabenochloral et le xylochloral (pp. 153-155). *Delacre*, Nouvelle synthèse de l'anthracene (pp. 155-157). *Guze, A.*, et *Fayollat, J.*, Contribution à l'étude des éthers tartriques (pp. 157-161).

Tome cxx. No. 4. (28th January, 1895.)

*Villard, P.*, Sur la dissolution des solides dans les vapeurs (pp. 182-184). *Garnier, J.*, Action d'un courant électrique sur une série de métaux sulfurés en fusion (pp. 184-186). *Ditte, A.*, Sur quelques propriétés du sulfure de bismuth (pp. 186-188). *Villiers, A.*, Influence du milieu ambient sur la transformation du sulfure de zinc amorphe (pp. 188-190). *Besson, A.*, Sur le chlorobromure et le bromure de carbonyle (pp. 190-192). *Rosenstiehl, A.*, Éthers mixtes et dérivés ammoniés de l'hexaméthyl-triamidotriphénylméthane (pp. 192-194). *Tanret, C.*, Sur les éthers acétiques des sucres (pp. 194-197). *Delépine*, Sur l'hexaméthylène-amine (pp. 197-200).

Tome cxx. No. 5. (4th February, 1895.)

*Pictet, R.*, Influences des basses températures sur la puissance d'attraction des aimants artificiels permanents (pp. 263-264). *Rosenstiehl, A.*, Dérivés monoiodammoniés de l'hexaméthyltriamidotriphénylméthane (pp. 264-266). *Bertrand, G.*, Sur la laccase et sur le pouvoir oxydant de cette diastase (pp. 266-270). *Battandier*, Réactions de la chélidonine avec les phénols en solution sulfurique (pp. 270-271).

15e Année. Tome i. No. 2. *Journal de Pharmacie et de Chimie.* (15th Jan., 1895.)

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# APPENDIX I.

## NOTICES OF BOOKS.

*Text-Book of the Diseases of Trees.* By Professor R. Hartig. Translated by William Somerville, D.Œc., B.Sc., F.R.S.E., F.L.S. Revised and edited with a Preface by H. Marshall Ward, D.Sc., F.R.S., F.L.S., F.R.H.S. Macmillan & Co., 1894.

Few names have become more intimately indentified with any special branch of scientific inquiry than has that of Hartig with Vegetable Pathology, and more particularly with that section of it which relates to the diseases of forest trees. It is with great pleasure then that we welcome the translation of the well-known German text-book on this subject. No one is more thoroughly qualified to command attention in this department than Professor Hartig himself, for it is in no small degree owing to the magnificent work which has been accomplished by him, that Forestry has become raised to the rank of a science which has successfully established its claim to recognition wherever the management of timbered estates is intelligently conducted.

It is greatly to be hoped that the appearance of an English edition of the *Lehrbuch* may serve to promote a more active interest in the whole subject, and that it may in so far prove effective in overcoming the ignorance and mismanagement which unfortunately still characterise the administration of most of the woods and forests in this country.

The book treats mainly of the injuries caused by parasites (chiefly fungi) to timber; and a brief account of the life history of these is usually given, in so far as it is of interest from the point of view of pathology. Furthermore, remedial measures are frequently indicated, so that not only is the book likely to be of use to the student, but it should also prove of indispensable value to the practical forester who has woodlands and forests under his charge.

*A Pocket Flora of Edinburgh and the Surrounding District.* By C. O. Sonntag. Williams & Norgate, 1894.

This little book may prove useful to persons who wish to become acquainted with the plants of the Edinburgh district. The area dealt with includes a considerable portion of East Scotland south of the Firth of Forth. Keys to the natural orders and genera are given, and to the description of the species, localiities and period of flowering are appended.

*The Genus Salpa.* By W. K. Brooks, Ph.D., LL.D., Professor in the Johns Hopkins University, and Director of its Marine Laboratory. Baltimore: Johns Hopkins Press, 1893.

This magnificent and important work of 396 pp., quarto, with 57 coloured plates, is the second memoir from the Biological Laboratory of the Johns Hopkins University. It is based upon the study of material for the greater part gathered and preserved at sea, by persons in charge of vessels of the U.S. Fish Commission; and the author acknowledges his indebtedness to the "Bache" Fund of the National Academy of Sciences. The monograph fulfils the promise of its author's earlier papers on the same subject. It opens with an introduction, in which the history of investigation of the genus, and its gross structure, haunts, habits, and physiology are, in turn, considered; and then follow three sections dealing with (i.) The Life-History of *Salpa;* (ii.) The Systematic Affinity of the Genus in their relation to the Conditions of Primitive Pelagic Life, the Phylogeny of the Tunicata, and the Ancestry of the Chordata, and (iii.) The Sexual and Asexual Development of *Salpa.* The leading refrain of the work is the acquiescence, with modification, to Grobben's conclusion that *Pyrosoma*, *Doliolum*, and *Salpa* are closely related forms, which have had a Compound Ascidian ancestry; but the author is of opinion that the ancestor did not possess the characters of any modern group. In having discovered (i.) that both in *Doliolum* and *Salpa* the variations of the muscular bands are such as to render untenable the subdivision into "Cyclomyaria" and "Desmo (*Hemi*) myaria"; (ii.) that the "elæoblast" of *Salpa* is homologous with the tail of *Doliolum*, the author has materially strengthened this position, not a new one for these two genera. He emphasises the fact that the young *Salpa*, especially in respect to its apertures, is much like a fixed Ascidian. Showing reason for regarding the "embryo" of *Salpa* as a

true embryo, and comparing it with the Cyathozooid of *Pyrosoma*, he argues that the ancestors of *Salpa* must have been developed from a yolk-laden egg. He seeks to show that the atrium of *Salpa* is homologous with that of the ordinary Ascidians, and that its ancestors further possessed numerous stigmatic "gill-slits" of the *Pyrosoma* type. Arguing along these lines, rejecting his earlier surmise that *Salpa* is the descendant of a pelagic free-swimming organism, he points out that it owes all its distinctive structural peculiarities to a sedentary life, and deduces the conclusion that *Salpa* is related to the Appendicularia indirectly through a fixed ancestral form, and not directly as Herdman has supposed for both *Salpa* and *Doliolum*.

In this generalisation the author is supported by his pupil, Mr. M. M. Metcalf, Fellow of the Johns Hopkins University, who contributes a subsidiary monograph upon "The Eyes and Sub-Neural Gland of *Salpa*". The salient feature of Mr. Metcalf's very careful piece of work is the discovery that the ganglion of *Salpa* may be resolved into a dorsal portion homologous with the adult Ascidian ganglion, and a ventral which represents the ventral wall of the visceral portion of the larval Ascidian nervous system, which gives rise to the sub-neural gland. Upon this basis he is led to deny the homology between the Salpa eye, and that of the Tunicate larva and the pineal eye of the higher vertebrata, believing the first-named to be the derivative of a portion of the nervous system not represented in the Ascidian tadpole and the vertebrata.

Dr. Brooks forcibly attacks the belief in the necessity of a physiological explanation of metamerism, which has entered so largely into recent zoological conceptions and theories of the inter-relationships of the higher groups of Metazoa. Restricting himself to a discussion of the origin of those pharyngeal structures especially characteristic of the Tunicata, the author proceeds to deal with the "Anneliden Hypothesis" of Dohrn in denunciatory terms, and he leads up to the conclusion that metamerism of the mesoderm and body-cavity may have resulted from the duplication of a single pair of cœlomic pouches probably acquired by the ancestors of the vertebrata after the divergence of the Tunicata. This definite attitude on the part of a worker so competent to assume one is very welcome, now that the ancestry of the vertebrata is much under discussion; and both in his arguments and evident desire to guard against the dangers of a too seductive "degeneration theory" the author has our full sympathy. Advocating the above-mentioned views, he reverts to the conception of the primitive nature of pelagic larvæ, and opposes that of the secondary origin of pelagic animals, by deviation and specialisation, from deeper living ancestors. Working along these lines, he enters into a discussion of "The Origin of the Chordata, considered in its relation to Pelagic Influences". In the course of this and other portions of the work we meet with an inclination towards the recapitulation theory of development, and that on what appear to us sound lines. The conclusions are reached that the primitive vertebrates lived upon or near the bottom, that the earliest steps in the evolution of the vertebrate classes were made there, and that all the Metazoa have still more remotely descended from small pelagic ancestors. Much of that portion of the book dealing with topics in which these conclusions centre, might well have been condensed and omitted; and it is irritating to find in a treatise so voluminous, and so well written that it is in parts almost racy, whole passages needlessly reiterated, and lengthy analogies to the affairs of daily life repeated word for word.

Among the more striking details recorded is the discovery that the surface of the *Salpa* body is delicately sculptured, and unequally thickened, apparently for purposes of support and restoration to shape after contraction (facts which are shown to have an important bearing on synonomy). The "follicle cells" are proved to be morphologically egg cells which do not become fertilised, and the embryo is shown to be "blocked out" in them in detail. These cells, however, do not become converted into the tissues of the definitive embryo, for they are used up as food for the true embryo cells, some of them wandering into the blastomeres during segmentation, others being said to migrate even into the ovarian eggs before fertilisation, to give rise to the much discussed "test-cells" of earlier investigators. For both these follicle cells and the placenta a nutritive function is claimed, and the author discards, on sufficient grounds, the notion that the placenta is a respiratory organ, and in any important respect comparable to that of the mammalia. Dr. Brook's work on the follicle cells has been already confirmed by Heider,[1] and as Mr. Metcalf's contribution passed through the press, Göppert published [2] a paper on the eye of Salpa, which peculiarly agrees with his in

[1] *Abhandlg. Senckenbg. Naturf. Gesellsch.*, bd. xviii., p. 367.
[2] *Morpholg. Jahrb.*, bd. xix., p. 250.

its results. The Brooks-Metcalf monograph will remain a standard work of reference on the subject with which it deals, and the drawings which accompany it, although a little crude at times, are so coloured as to facilitate ease of identification of the complex parts delineated.

*An Introduction to Physical Measurements.* By Dr. F. Kohlrausch. Pp. 476. London: J. & A. Churchill, 1894.

The original German edition of this work appeared in 1869, and was therefore one of the very first manuals for use in the physical laboratory. In spite of its numerous competitors at the present time, there can be no better proof of its merits than the fact that it still holds its own as a laboratory guide; the volume under notice being a translation of the seventh German edition, and the third edition appearing in English. As is well known, the book is only intended for use in actual practice, and contains clear and concise accounts, shorn of all technical detail, of the apparatus and methods employed in a complete course of instruction.

In the present edition new methods, such as those dealing with solutions, have been added, but its main feature is the introduction of explanations and directions which refer rather to investigation and research than to the practice necessary for students.

*A Text-Book of Magnetism and Electricity.* By R. W. Stewart, D.Sc. (Lond.). Second edition. Pp. 344. London: University Correspondence College Press.

This book is written for students preparing for the Intermediate Science and less advanced examinations of the University of London. Although it is constructed on the lines of a "cram" book, it is only fair to say that it is one of the best of its kind. Under the limitations laid down by the author, it is a clearly written and satisfactory introduction to electricity and magnetism.

*A Text-Book of Dynamics.* By W. Briggs, M.A., LL.B., F.R.A.S., and G. H. Bryan, M.A. Pp. 192 and xiv. London: University Correspondence College Press.

This is a sound elementary exposition of the principles of dynamics, treated with the minimum amount of mathematics, and illustrated by means of well-chosen examples and phenomena familiar to the reader.

# APPENDIX II.

## ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN FEBRUARY, 1895.

Vol. xvii. No. 3. *Journal of the American Chemical Society.* (March, 1895.)

*Wiley, H. W.*, The Synthetic Food of the Future (pp. 155-178). *Pemberton, H.*, The Determination of Phosphoric Acid (pp. 178-181). *Lunge, G.*, On the Estimation of Sulphur in Pyrites (181-187). *Squibb, E. R.*, Improvement in the Manufacture of Acetone (pp. 187-201). *Clarke, F. W.*, Report of Committee on Atomic Weights, published during 1894 (pp. 201-213). *Bigelow, W. D.*, Colouring Matter in the California Red Wine (pp. 213-218). *Bowen, H. C.*, The Penetration Machine—An Explanation (pp. 218-219).

Vol. lxvii. No. 388. *Journal of the Chemical Society.* (March, 1895.)

*Ling, A. R.*, and *Baker, J. L.*, Octacetylmaltose (pp. 212-215). *Collie, J. N.*, Action of Heat on Ethylic β-Amidocrotonate II. (pp. 215-226). *Divers, E.*, The Acid Sulphate of Hydroxylamine (pp. 226-227). *Hada, S.*, Mercury and Bismuth Hypophosphites (pp. 227-230). *Perkin, A. G.*, Kamala II. (pp. 230-239). *Littleton, F. T.*, Remarkable Molecular Change in a Silver Amalgam (pp. 239-242). *Walker, C.*, Chemical Composition of two Silver Ornaments from Inca Graves at Chimbote, Peru (pp. 242-246). *MacCallum, W., jun.*, Derivatives of Ethylorthotoluidine (pp. 246-251). *Haga, T.*, and *Osaka, Y.*, Acidimetry of Hydrogen Fluoride (pp. 251-255).

Vol. xiv. No. 1. *Journal of the Society of Chemical Industry.* (31st Jan., 1895.)

*Attfield, D. H.*, An Investigation of the Natural Solidified Sodium Sulphate Lakes of Wyoming, U.S.A. (pp. 3-8). *Flintoff, R. J.*, Note on the Formation of Magenta during the Development of Aniline Black on Cotton (pp. 8-9). *Foster, R. N.*, The Prevention of Smoke Arising from Intermittent Firing in Various Processes of Chemical and Allied Industries (pp. 9-12).

Vol. xxxix. No. 238. *Philosophical Magazine and Journal of Science.* (March, 1895.)

*Dewar, J.*, On the Liquefaction of Gases (pp. 298-305). *Prytz, K.*, An Experiment with Solid Carbonic Acid (p. 308).

Series 7. Tome iv. *Annales de Chimie et de Physique.* (March, 1895.)

*Guerbet*, Contribution à l'étude de l'acide campholique (pp. 289-365). *Moissan, H.*, Sur quelques modèles nouveaux de fours électriques à reverbère et à électrodes mobiles (pp. 365-391). *Gossart, E.*, Caléfaction et capillarité (pp. 391-424). *Savéliief, R.*, Sur le degré de précision que l'on peut atteindre dans les observations actinométriques (pp. 424-429). *Berthelot*, Remarques sur l'inertie des agents oxydants ou réducteurs dans les analyses par voie humide (pp. 429-432).

Tome xiii.-xiv. No. 4. *Bulletin de la Société Chimique de Paris.* (20th Février, 1895.)

*Villiers, A.*, Sur les sulfures de nickel et de cobalt (pp. 165-170). *Villiers, A.*, Sur la séparation qualitative du nickel et du cobalt (pp. 170-171). *Villiers, A.*, Sur l'état protomorphique ; sulfures de zinc et de manganèse (pp. 171-175). *Athanasesco*, Recherches sur les nitrates basiques (pp. 175-182). *Guye, Ph. A.*, et *Jeanprêtre, J.*, Sur l'acide octylique 2-éthyl-4-méthylpentanoïque (pp. 182-186). *Welt, J.*, Sur l'acide amylacétique actif et quelques-uns de ses dérivés (pp. 186-190). *Guye, Ph. A.*, et *Fayollat, J.*, Contribution à l'étude des éthers tartriques (pp. 190-209). *Cambier, R.*, et *Brochet, A.*, Sur l'hexaméthylène-tétramine (pp. 209-214). *Reverdin, F.*, Sur un nouveau procédé de fabrication de l'acide α-naphtolsulfonique $C_{10}H_6 . OH . HSO_3$. 1-4 (pp. 214-218). *Prud'homme, M.*, Sur les matières colorantes sulfonées dérivées du triphénylméthane (pp. 218-222). *Delépine*, Insuffisance de la méthode de Kjeldahl pour le dosage de l'azote dans les chloroplatinates (pp. 222-223).

Tomes xiii.-xiv. No. 5. (5th Mars, 1895.)

*Berlemont*, Régulateur de température (pp. 228-229). *Thomas, V.*, Sur quelques dérivés d'addition du perchlorure de fer et du bioxyde d'azote (pp. 229-231). *Colson, A.*, Éthers cyanés et nitrites d'alcools (pp. 231-238). *Juillard, P.*, Sur l'acide dioxystéarique naturel (pp. 238-240). *Juillard, P.*, Sur la triricénoléine ; ses éthers, sa synthèse (huile de ricin artificielle) (pp. 240-247). *Lefèvre, L.*, Sur la constitution du vert à l'iode (pp. 247-252). *Bertrand, G.*, et *Mallèvre, A.*, Recherches sur la pectase et sur la fermentation pectique II. (pp. 252-256).

Tome cxx. No. 6. *Comptes Rendus hebdomadaires de l'Académie des Sciences.* (11th February, 1895.)

*Berthelot*, et *Andre, G.*, Sur la présence de l'alumine dans les plantes et sur sa répartition (pp. 288-290). *Moissan, H.*, Preparation et propriétés du titane (pp. 290-296). *Haller, A.*, et *Guyot, A.*, Sur quelques dérivés de phénolphtaléine (pp. 296-299). *Ponsot, A.*, Sur l'abaissement du point de congélation des dissolutions étendues de chlorure de sodium (pp. 317-320). *Ditte, A.*, Sur le sulfure d'or (pp. 320-322). *Villiers, A.*, Sur une méthode pour déterminer la cristallisation des précipités. Sulfure de zinc et de manganèse, hydrate d'oxyde de cuivre (pp. 322-325). *Jungfleisch, E.*, et *Léger E.*, Sur la cinchonigine ; dimorphisme d'un composé présentant le pouvoir rotatorie moléculaire spécifique (pp. 325-328). *Étard, A.*, Pluralite des chlorophylles. Deuxième chlorophylle isolée dans la luzerne (pp. 328-331). *Rosenstiehl, A.*, Comparaison entre les dérivés colorés et les dérivés incolores de l'hexaméthyl-triamido-triphénylméthane (pp. 331-333). *Henry, L.*, Sur un éther d'un genre nouveau ; le lactate de méthylèone (pp. 333-335).

Tome cxx. No. 7. (18th February, 1895.)

*Gautier, A.*, Sur la pluralité des chlorophylles. Remarques à propos de la Note de M. Étard (pp. 355-356). *Girard, A.*, Sur le dosage des composés tanniques (pp. 358-361), *De Boisbaudran, L.*, Remarques sur les poids atomiques (pp, 361-362). *Vigouroux*, Sur les propriétés du silicium amorphe (pp. 367-370). *Lindet, L.*, Sur l'oxydation du tanin de la pomme à cidre (pp. 370-372). *Rocques*, Sur la composition et l'analyse des eaux-de-vie (pp. 372-374). *Lecomte, H.*, et *Herbert, A.*, Sur les graines de Moâbe (pp. 374-377). *Dufet, H.*, Sur les ferrocyanure, ruthénocyanure et osmiocyanure de potassium (pp. 377-379).

Tome cxx. No. 8. (25th February, 1895.)

*Haller, A.*, et *Muller, Th. P.*, Etude ébullioscopique de certains colorants du triphenylméthane (pp. 410-413), *Ponsot, A.*, Abaissement du point de congelation, et diminution relative de la tension de vapeur dans les dissolutions étendues (pp. 434-436). *Leduc, A.*, Sur l'abaissement du point de congélation des dissolutions très diluées (pp. 436-439). *Charpentier, P.*, Sur un *pressomètre* sensible, pour la mesure des pressions des fluides (pp. 439-441). *Lemoine, G.*, Mesure de l'intensite de la lumière par l'action chemique produite ; expériences avec les mélanges de chlorure ferrique et d'acide oxalique (pp. 441-444). *Mosnier, A.*, Sur quelques combinaisons de l'iodure de plomb avec d'autres iodures métalliques ou organiques (pp. 444-447). *Thomas, V.*, Sur quelques combinaisons du bioxyde d'azote avec les chlorures de fer (pp. 447-449). *Brochet, A.*, et *Cambier, R.*, Action de l'aldehyde formique sur le chlorhydrate d'hydroxylamine et le chlorhydrate de monométhylamine (pp. 449-452). *Guye, Ph. A.*, et *Chavanne, L.*, Éther amyliques actifs (pp. 452-455).

15e Année. Tome i. No. 4. *Journal de Pharmacie et de Chimie.* (15th Feb., 1895.)

*Bourquelot*, Le sirop d'iodure de fer (pp. 170-175). *Villiers, A.*, Sur la séparation qualitative du nickel et du cobalt (pp. 175-178). *Hugouneng*, Sur une falsification des peptones commerciales (pp. 178-181).

Tome i. No. 5. (1st March, 1895.)

*Fleury*, Un empoisonnement au moyen du sel d'oseille (pp. 225-226). *Guérin, G.*, Essai de diagnose des liquides ovariens et ascitiques (pp. 226-228). *Tanret*, Sur les éthers acétiques des sucres (pp. 228-232). *Ruizand*, Sur deux réactions pratiques permettant de différencier la lactose du glucose dans les peptones falsifiées (pp. 232-233). *Villiers, A.*, Sur les sulfures de nickel et de cobalt (pp. 238-243).

Tome xxvi. No. 9. *Journal de la société physico-chemique russe.*

*Sélivanoff, Th.*, Recherches sur les combinaisons halogénées de l'azote (pp. 497-559). *Faworsky, Al.*, Rescherches sur les changements isomériques parmi les cétones, les aldehydes, les alcohols chlorés et les oxydes chlorosubstitués I. (pp. 559-603).

Jahrgang xxviii. No. 2. *Berichte der Deutschen Chemischen Gesellschaft.* (11th February, 1895.)

*Doebner, O.*, Ueber Chinolinbasen im Braunkohlentheer (pp. 106-108). *Pawlewski, B.*, Ueber Isophenylphtalëin und Allofluoresceïn (108-109). *Bender, F.*, Ueber Derivate des p-Dimethylamidobenzaldehyds (pp. 109-111). *Staedel, W.*, Ueber Oxydiphenylenketone und Oxydiphenylcarbonsäuren (pp. 111-114). *Henriques, R.*, Ueber Thioderivate des β-Naphtols (p. 114). *Marchwald, W.*, Die Constitution der Ringsysteme (pp. 114-116). *Lagodzinski, K.*, Neue Synthese von Chinizarin und Hystazarin (pp. 116-119). *Reissert, A.*, Ueber einige Abkömmlinge des α-Chinochinolins (pp. 119-129). *Liebermann, C.*, Ueber Allofurfuracrylsäure (pp. 128-134). *Liebermann, C.*, Zur Constitution der Phenylmonobromacrylsäuren (Bromzimtsäuren) (pp. 134-137). *Liebermann, C.*, Ueber α- und β-Isatropasäure (pp. 137-143). *Liebermann, C.*, Ueber das Verhalten von Alkylidenmalonsäuren und deren Ester gegen Brom (pp. 143-145). *Blank, R.*, Ueber die Addition von Anilin und Phenylhydrazin an Benzalmalonsäureester (pp. 145-148). *Crompton, H.*, Beziehung Zwischen Valenz und Atomvolum (pp. 148-149). *Pinnow, J.*, und *Müller, E.*, Ueber die Reduction des o-Nitrobenzonitrils (pp. 149-160). *Wolff, H.*, Ueber Dextrosebenzhydrazid (pp. 160-163). *Ladenburg, A.*, Ueber r-Coniin (pp. 163-165). *Michaelis A.*, und *Luxembourg, K.*, Ueber eine neue Reihe schwefelhaltiger Derivate der aliphatischen Amine (pp. 165-167). *Winterstein, E.*, Ueber die Spaltungsproducte der Pilzcellulose (pp. 167-170). *V. Pechmann, H.*, und *Frobenius, L.*, Nachträgliches ueber aromatische Diazoverbindungen (170-176).

Jahrgang xxviii. No 3. (25th February, 1895.)

*Meyer V.*, Weiteres ueber die Esterbildung aromatischer Säuren (pp. 182-190). *Jackson, C. L.*, und *Galliran, F. B.*, Ueber einige Derivate des unsymmetrischen Tribromobenzol (pp. 190-192). *Freund, M.*, Zur Geschichte des Aconitins; Erwiderung an Hrn. W. R. Dunstan (pp. 192-195). *Thaddéeff, K.*, Ueber gewisse aus dem Gewichte der Tropfen geschmolzener metalle sich ergebende Gesetzmässigkeiten (pp. 195-202). *Meyer, V.*, Ueber Natrium-nitroäthan (pp. 202-205). *Weil, H.*, Die Constitution der Farbbasen der Triphenylmethanreihe I (pp. 205-215). *Buchner, E.*, Ueber Quecksilberdiazoessigester (pp. 215-221). *Buchner, E.* und *Papendieck A.*, Einwirkung von Diazoessigester auf ungesättigte Säureester (pp. 221-224). *Bamberger, E.*, Ueber Diazoester (pp. 225-245). *Bamberger, E.*, Ueber die Reduction aromatischer Nitroverbindungen (pp. 245-251). *Rupe, H.*, Ueber Imidazolone (Ureïde) von α-Ketonalkoholen und ihre Spaltungsproducte II. (pp. 251-261). *Tollens, B.*, Ueber eine Lampe zur Herstellung von Formaldehyd (pp. 261-263). *Auwers, K.*, Ueber Trimethylbernsteinsäure und symmetrische αα-Dimethylglutarsäuren (pp. 263-270) *Jaubert, G. F.*, Beiträge zur Constitution der Safranine (pp. 270-276). *Spieckermann A.*, Ueber Stearoxyl und Behenoxylsäure (pp. 276-279). *Bischler, A*, und *Lang, M.*, Zur Kenntniss der Phenmiazinderivate (pp. 279-293), *Fischer, O.* und *Hepp, E.*, Ueber die Fluorindine II. (pp. 293-302). *Wolffenstein, R.*, Ueber Coniumalkaloïde (pp. 302-306).

Band li. Nos. 3, 4. *Journal für praktische Chemie.* (31st January, 1895.)

*Busch, M.*, Zur Kenntniss der o-Amidobenzylamine, I. (pp. 113-140). *V. Rothenburg, R.*, Synthetische Versuche in der Pyridazolreihe, II. (pp. 140-157). *V. Rothenburg, R.*, Isomeriefälle in der Pyrazolreihe (pp. 157-165). *Trachmann, O.*, Die drei Mono-Nitrobenzhydrazide (pp. 165-180). *Schöfer, G.*, und *Schwann, N.*, Ueber einige Hydrazide einbasischer und zweibasischer Säuren der Fettreihe (pp. 180-197). *Fileti*, Ueber das Moleculargewicht des Quecksilberchlorürs; Antwort an Herrn. V. Meyer (pp. 197-204). *Edinger, A.*, Zur Kenntnsis des Jodisochinolins (pp. 204-210). *Kauschke, P.*, Ueber die Einwirkung von Brom auf salicylsaures und benzoësaures Phenyl, benzoësaures o-, m- und p-Kresyl, und benzoësaures Guajakol (pp. 210-214). *Rayleigh* und *Ramsay, W.*, Argon, ein neuer Gemengtheil der Atmosphäre (pp. 214-

**Band xv. Heft 10.** ***Monatshefte für Chemie und Verwandte Thiele anderer Wissenschaften.*** **(28th January, 1895.)**

*Georgievics, G., V.*, Ueber das Wesen des Färbeprocesses (pp. 705-719). *Hübner, E.*, Ueber das Verhalten der Kalksalze einiger aromatischer Aethersäuren bei der trockenen Destillation (pp. 719-739). *Pomeranz, C.*, Ueber den Phenyläther des Glycolaldehyds (pp. 739-747). *Brunner, K.*, Bildung von Propyltartron-säuren aus den Dibutyryldicyaniden (pp. 747-775). *Skrup, Z. H.*, Ueber die Affinität einiger Basen in alkoholischer Lösung (pp. 775-787). *Ratz, F.*, Ueber das Cinchotenin (pp. 787-803). *Gintl, W. H.*, Ueber das Verhalten des äthylglycolsauren Kalkes bei der trockenen Destillation (pp. 803-807). *Jeiteles, B.* Ueber ein Cyanid und eine Carbonsäure des Isochinolins (pp. 807-820).

**Band viii. Heft 3.** ***Zeitschrift für Anorganische Chemie.*** **(11th February, 1895.)**

*Werner, A.*, Beitrag zur Konstitution anorganischer Verbindungen, II. (pp. 153-189). *Werner, A.*, Beitrag zur Konstitution anorganischer Verbindungen, III. (pp. 189-198). *Pennington, M. E.*, und *Smith, E. F.*, Ueber das Atomgewicht von Wolfram (pp. 198. 205). *Smith, E. F.*, und *Desi, E. D.*, Ueber das Atomgewicht des Wolframs (pp. 205-207). *Grodspeed, A. W.*, und *Smith, E. F.*, Ueber die spezifische Wärme des metallischen Wolframs (pp. 207-213). *Arctowski, H.*, Ueber die doppelte Umsetzung bei gasförmigen Körpern (pp. 213-224).

**Band xx. Heft 4.** ***Zeitschrift für Physiologische Chemie.*** **(7th Feb., 1895.)**

*Tschermak, A.*, Ueber die Stellung der amyloiden Substanz unter den Eiweisskörpern (pp. 343-357). *Mörner, C. T.*, Einige Beobactungen ueber die Verbreitung der Chondroitinschwefelsäure (pp. 357-364). *Schmidt, E.*, Notiz ueber das Cholin (pp. 364-365). *Hoppe-Seyler, F.*, und *Araki, T.*, Ueber de Einwirkung der bei Sauerstoffmangel im Harne ausgeschiedenen Milchsäure auf polarisirtes Licht und die Rotationswerthe activer Milchsäuren im Allgemeinen (pp. 365-377). *Vay, F.*, Ueber den Ferralin und Eisengehalt der Leber (pp. 377-403). *Mohr., P.*, Ueber den Schwefelgehalt verschiedener Keratinsubstanzen (pp. 403-407). *Weiss, F.*, Ueber die Anhydroester der α-Aminosäuren und eine Synthese der Mercaptursäuren (pp. 407-435). *Fränkel, S.*, Ueber einige Derivate der Bromphenylmercaptursäure (pp. 435-442).

**Anno xxv. Vol 1. Fascicolo 1.** ***Gazetta Chimica Italiana.*** **(7th Feb., 1895.)**

*Anderlini, F.*, e *Salvadori, R.*, Ricerche comparate sopra i metodi di destillazione frazionata (pp. 1-31). *Alvisi, W.*, Osservazioni sulle relazioni tra il peso molecolare e la densità dei corpi solidi e liquidi (pp. 31-42). *Marchetti, G.*, Sopra un nuovo alcool della lanolina (pp. 42-49). *De Sanctis, G.*, Sull' esistenza della Conüna nel Sambucus nigra (pp. 49-53). *Cannizzaro, S.*, e *Andreocci, A.*, Studio de dimetilnaftol (p. 53-59). *Oliveri, V.*, Sulla costruzione della nicotina (pp. 59-78). *Grimaldi, S.*, Azione dell' urea sui chenoni (pp. 78-79).

# APPENDIX I.

## NOTICES OF BOOKS.

*Annals of British Geology*, 1893. A digest of the books and papers published during the year; with an introductory review. By J. F. Blake, M.A., F.G.S. London: Dulau & Co., 1895.

British geologists are to be congratulated on having presented to them in so convenient a form a *resumé* of the work published during the year. The volume contains abstracts of no fewer than 730 books and papers, and forms an invaluable guide to those who have access to the originals, whilst to those who have not such access the abstracts will in most cases furnish all the information necessary. The value of the work is much increased by the presence of figures, most of which illustrate newly-described species of fossils, and are reproduced by photography from the original drawings. Several, however, are woodcuts, and these are mainly used to illustrate sections.

Of considerable value is the introductory review, which occupies twenty-four pages, and in which the author classifies and criticises the more important publications of the year. The work may be cordially recommended to those engaged in the study of geology.

*Collected Papers on some Controverted Questions of Geology.* By Joseph Prestwich, D.C.L. (Oxon.), F.R.S., F.G.S. London: Macmillan & Co., 1895.

The present volume consists of a series of reprints from the *Nineteenth Century*, the *Quarterly Journal of the Geological Society*, the *Journal of the Anthropological Institute*, and the *Proceedings of the Royal Society*.

The first two articles are devoted to a consideration of geological time, Professor Prestwich setting forth his well-known views as to the uniformity of geological changes through all time. The opinion most prevalent in England up to the present time has been that the agencies concerned in causing changes at the surface of the globe have acted with perfect uniformity, not only so far as the kind of action is concerned, but also with regard to the *rate* at which these changes were produced, and only a comparatively few years ago the number of English geologists who regarded any variation in this rate as probable might easily be counted on the fingers of one hand. At the present time, however, there seems a tendency to admit the possibility of a faster rate of change in the conditions of increased precipitation and heightened temperature which existed at former periods of the world's history, and this would be an approach to the position maintained by Professor Prestwich, *viz.*, that there has always existed uniformity in kind, but no uniformity in degree.

The second paper deals with the above consideration in conjunction with Croll's theory as to chronological measurements as bearing on the antiquity of man.

The third paper deals with the age of plateau man, whilst the agency of water in volcanic eruptions is treated in the fourth, an attempt being made to show that the cause of the vast escape of steam from active volcanoes is not that water exists occluded in the lava at the volcanic foci, but that the waters are surface waters, which in their descent come in contact with the lava in the duct of the volcano as it approaches the surface.

The questions of the thickness of the earth's crust and the rate of increase of temperature on descending through that crust are treated and discussed in the two last articles.

Professor Prestwich's views on these subjects are always welcome, and geologists will be glad to have the present set of collected papers put into their hands in a convenient and easily accessible form.

*A Popular Treatise on the Physiology of Plants.* By Dr. Paul Sorauer, Director of the Experimental Station at the Royal Pomological Institute in Proskau (Silesia). Translated by F. E. Weiss, B.Sc., F.L.S., Professor of Botany at the Owens College, Manchester. London: Longmans, Green, & Co., 1895.

If it is to the inconvenience experienced by Professor Weiss from the want of a text-book suitable for his gardener-students at Manchester that we owe the present translation of Dr.

Sorauer's excellent book, we must regard it as an example of the old saying that "it is an ill wind that blows nobody any good". For though there will always be a large number of gardeners in England who will continue to practise their calling entirely by rule of thumb, nevertheless the advance of education is undoubtedly leading to a feeling on the part of many that they would do better for their charges if they knew more about them, and in many cases the knowledge is desired also for its own sake. As the demand for advanced instruction arises, the supply will follow, and to any one who is engaged in organising classes in consequence of this demand, we can cordially recommend as a text-book the volume which forms the subject of the present notice.

Arranged upon a clear and comprehensive plan, clearly written, and conveniently broken up into sections with appropriate headings, the book is one which will appeal strongly to practical men, as in it they may find in simple language answers to questions which must constantly recur in the ordinary course of their work. Dr. Sorauer's many years' experience in connection with an institution engaged in training practical men has stood him in good stead here, and he obviously understands perfectly well how to appeal to unscientific readers by writing in a somewhat popular style. It must, however, be confessed that there are a few errors, or at anyrate misleading statements, which here and there meet the reader, and it is perhaps to be regretted that Professor Weiss did not exercise editorial discretion in these cases a little more severely. In other respects, however, he has performed his task in a workmanlike manner, and the translation runs easily and well. The figures also are clear and good, a point of much importance in a work like the present.

# APPENDIX II.

## ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN MARCH, 1895.

### Vol. xvii. No. 3. *American Chemical Journal* (March, 1895.)

*Richards, T. W.*, and *Whitridge, A. H.*, On the Cupriammonium Double Salts (pp. 145-152). *Richards, T. W.*, The Composition of Athenian Pottery (pp. 152-154). *Jones, H. C.*, A Redetermination of the Atomic Weight of Yttrium (pp. 154-164). *Campbell, E. D.*, and *Andrews, W. H.*, Separation of Nickel and Iron (pp. 164-167). *Gibbs, W.*, Researches on the Complex Inorganic Acids (pp. 167-185). *Bartlett, E. J.*, and *Merrill, W. H.*, Cupric Hydride (pp. 185-189). *Norris, R. S.*, Action of Light on Lead Bromide (pp. 189-191). *Stone, W. E.*, The Action of Ammonia upon Dextrose (pp. 191-196). *Stone, W. E.*, The Carbohydrates of the Gum of Acacia Decurrens (pp. 196-199).

### Vol. xvii. No. 4. *Journal of the American Chemical Society.* (April, 1895.)

*Handy, J. O.*, The Superiority of Barium Hydroxide Solution as an Absorbent in Carbon Determinations in Steel (pp. 247-251). *Norton, T. H.*, The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagration (pp. 251-260). *McElroy, K. P.*, Note on the Estimation of Iron and Alumina in Phosphates (pp. 260-263). *Blomén, J. E.*, Some Practical Points in the Manufacture of Nitroglycerol (pp. 263-277). *Barton, G. E.*, Methods for the Examination of Glycerol for use in the Nitroglycerol Manufacture (pp. 277-280). *Whitehead, C.*, Estimation of Tellurium in Copper Bullion (pp. 280-281). *Horton, H. E.*, The Use of Sulphurous Acid ($HNa\,SO_3$) in Manufacture of Glucose Syrup and Grape Sugar (pp. 281-286). *Cross, C. F., Bevan, E. J.*, and *Beadle, C.*, The Furfurol-Yielding Constituents of Plants (pp. 286-289). *Twitchell, E.*, The Separation of Solid and Liquid Fatty Acids (pp. 289-296). *Bachman, I. A.*, Improved Methods of Water Analysis (pp. 296-304). *Andrews, W. W.*, A Cheap Form of Self-Regulating Gas Generator (pp. 304-306). *Venable, F. P.*, and *Clarke, T.*, Some of the Properties of Calcium Carbide (pp. 306-310). *Shimer, P. W.*, Note on the Determination of Zinc (pp. 310-312). *Weber, H. A.*, and *McPherson, W.*, On the Determination of Cane Sugar in the Presence of Commercial Glucose (pp. 312-320). *Weber, H. A.*, and *McPherson, W.*, On the Action of Acetic and Hydrochloric Acids on Sucrose (pp. 320-327). *Clark, E.*, Method of Determining Chromium in Chrome Ore (pp. 327-330).

### Vol. xx. No. 228. *The Analyst.* (March, 1895.)

*Hehner, O.*, On the Determination of the Bromine Absorption of Fats Gravimetrically (pp. 49-54). *Richmond, H. D.*, The Composition and Analysis of Milk and Milk Products (pp. 54-57). *Richmond, H. D.*, The Relation between Specific Gravity, Fat and Solids-not-Fat in Milk (pp. 57-58). *Richmond, H. D.*, Waumené's Tests for Oils (58-59).

### Vol. lxvii. No. 389. *Journal of the Chemical Society.* (April, 1895.)

*Perkin, W. H.*, The Magnetic Rotation of some Unsaturated Hydrocarbons (pp. 255-264). *Bentley, W. H.*, $\beta\beta$-Methyl-ethylpropionic acid $\begin{matrix}CH_3\\C_2H_5\end{matrix}\!\!>\!CH\cdot CH_2\cdot COOH$ (pp. 264-268). *Reddrop, J.*, and *Ramage, H.*, Volumetric Estimation of Manganese (pp. 268-277). *Bloxam, W. P.*, The Sulphides and Polysulphides of Ammonium (pp. 277-309). *Brown, H. T.*, and *Morris, G. H.*, Note on the Action of Diastase on Cold Starch-paste (pp. 309-314). *Plimpton, R. T.*, and *Chorley, J. C.*, Titration of Iodine Solutions with Barium Thiosulphate (pp. 314-315). *Crompton, H.*, On Latent Heat of Fusion (pp. 315-327). *Crompton, H.*, and *Whiteley, M. A.*, The Melting Point of Mixtures (pp. 327-337). *Walker, J.*, and *Henderson J.*, Electrolysis of Potassium Allo-ethylic Camphorate (pp. 337-349). *Kipping, F. S.*, Dimethylketohexamethylene (pp. 349-354). *Kipping, F. S.*, and *Pope, W. J.*, Sulphonic Derivatives of Camphor II. (pp. 354-370).

Vol. xiv. No. 2. *Journal of the Society of Chemical Industry.* (28th Feb., 1895.)

*Wright, L. T.*, On the Efficiency of Carbon Vapour in Coal Gas and other Hydrocarbon Flames, and other Matters of Interest in the Manufacture of Coal Gas (pp. 103-110). *Tate, F.*, Some Applications of Refrigeration (pp. 110-112). *Smetham, A.*, The Influence of Oxide of Iron and Alumina in the Reversion of Superphosphate (pp. 112-114). *Carpenter, R. F.*, Notes on Acetylene (pp. 115-116). *Carulla, F. J. R.*, Recent Experiences when putting up a Steam Boiler (pp. 116-122). *Procter, H. R.*, On a Modified Form of Tintometer or Colorimeter (pp. 122-124). *Parker, J. G.*, and *Procter, H. R.*, The Estimation and Numerical Expression of Colour in Tanning Materials (pp. 124-127). *Endemann, H.*, On the Utilisation of Magnesia obtained as a By-Product in the Manufacture of Carbonic Acid from Magnesite (pp. 127-129). *Schweitzer, H.*, and *Lungwitz, E.*, Notes on the Analysis of Lard Oil (p. 129). *Schweitzer, H.*, and *Lungwitz, E.*, Notes on the Analysis of Whale Oil (p. 130). *Schweitzer, H.*, and *Lungwitz, E.*, The Correct Iodine Number (pp. 130-133).

Series 7. Tome iv. *Annales de Chimie et de Physique.* (April, 1895.)

*Berthelot*, Recherches Thermo-Chimiques sur les Substitutions en Chimie Minérale (pp. 433-494). *Recoura, A.*, Recherches sur le Sulfate Chromique, ses Transformations et le Acides Complexes qui en Dérivent (pp. 494-528). *Oechsner de Coninck*, Recherches sur quelques Acides Aromatiques et sur l'Isomérie dans la série Aromatique (pp. 528-546). *Berthelot*, Étude sur les métaux qui composent les objets de cuivre, de bronze, d'étain, d'or, d'argent, découverts par M. de Morgan dans les fouilles de Dahchour, ou provenant du musée de Gizèh (pp. 546-575).

Tome xiii.-xiv. No. 6. *Bulletin de la Société Chimique de Paris.* (20 Mars, 1895.)

*Tanret, C.*, Sur les éthers acétiques de quelques sucres (pp. 261-273). *Rosenstiehl, A.*, Des produits de l'oxydation du tétraméthyldiamidophénylhydrol (pp. 273-275). *Rosenstiehl, A.*, De l'instabilité du tétraméthyldiamidophénylhydrol (pp. 275-277). *Lindet, L.*, Sur l'oxydation du tannin de la pomme à cidre (pp. 277-280). *Lescoeur, H.*, Sur le dosage volumétrique des métaux (pp. 280-281). *Lapicque, L.*, Quantité de fer contenue dans l'urine (pp. 281-286).

Tome cxx. No. 9. *Comptes Rendus hebdomadaires de l'Académie des Sciences.* (4th March, 1895.)

*Villiers, A.*, Oxydes et sulfure à fonction acide et à fonction basique. Sulfure de zinc (pp. 498-500). *Monnet, E.*, Recherches calorimétriques sur les dissolutions salines. Acétate de soude (pp. 500-501). *Delépine*, Sur l'hexamethylène-amine; sels d'ammonium; action des acides; production d'amines primaires (pp. 501-502).

Tome cxx. No. 10. (11th March, 1895.)

*Berthelot*, Sur l'argon (pp. 521-522). *Schloesing*, Sur les pertes d'azote entraîné par les eaux d'infiltration (pp. 526-531). *Chatin, A.*, et *Muntz, A.*, Analyse des coquilles d'huitres (pp. 531-534). *Vigouroux*, Sur l'analyse du silicium (pp. 554-557). *Brochet, A.*, et *Cambier, R.*, Action de l'aldéhyde formique sur les sels ammoniacaux (pp. 557-560). *Rivals, P.*, Sur les chlorures acides et les aldéhydes chlorés (pp. 560-562). *Guye, P. A.*, et *Jordan, C.*, Dédoublement de l'acide butane-2-oloïque (α-oxybutyrique). *Gérard, E.*, Sur l'acide daturique (pp. 565-567). *Kaufmann*, Glycogène dans le sang chez les animaux normaux et diabétiques (pp. 567-568). *Tissot, J.*, Sur la signification du dégagement d'acide carbonique par des muscles isolés du corps, comparée à celle de l'absorption de l'oxygène (pp. 568-570).

Tome cxx. No. 11. (18th March, 1895.)

*Berthelot*, Essais pour faire entrer l'argon en combinaison chimique (pp. 581-585). *Korda, D.*, Pile thermochimique à charbon (pp. 615-618). *Sabatier, P.*, et *Senderens, J. B.*, Action de l'oxyde azoteux sur les métaux et sur les oxydes métalliques (pp. 618-620). *Varet, R.*, Sur les états isomériques des oxydes de mercure (pp. 622-623). *Varet, R.*, Recherches sur les chaleurs de combinaison du mercure avec les éléments (pp. 620-622). *Le Chatelier, H.*, Sur la chaleur de formation de quelques composés du fer (pp. 623-625). *Rivals, P.*, Sur

les aldéhydes chlorés (pp. 625-627). *Rivals, P.*, Sur les polymère cristallisé de l'aldéhyde monochloré (pp. 627-628). *Denigès, G.*, Sur une combinaison mercurique du thiophène, permettant le dosage et l'extraction de ce corps dans les benzène commerciaux (pp. 628-630). *Tanret, C.*, Sur l'état amorphe des corps fondus (pp. 630-632). *Guye, P.*, et *Jordan, C.*, Dérivés de l'acide α-oxybutyrique (1-butanoloïque) actif (pp. 632-635).

Tome cxx. No 12. (25th March, 1895.)

*Berthelot*, Nouvelles recherches de M. Ramsay sur l'argon et sur l'hélium (pp. 660-662). *Berthelot*, Remarques sur les spectres de l'argon et de l'aurore boréale (pp. 662-663). *Schutzenberger, P.*, Recherches sur les métaux de la cérite (pp. 663-668). *Duboin, A.*, Sur l'extension à la magnésie d'une méthode de synthèse de fluorures et de silicates (pp. 678-681). *Pigeon, L.*, Sur un nouveau mode de préparation de l'acide chloroplatineux et de ses sels (pp. 681-682). *De Forcrand*, Chaleur de formation de l'acétylure de calcium (pp. 682-684). *Ville, J.*, et *Astre, C.*, Action de l'acide o-aminobenzoïque sur la benzoquinone (pp. 684-687). *Petit, P.*, Variations des matières sucrées pendant la germination de l'orge (pp. 687-689). *Bordas F.*, et *Girard, C.*, Procédé chimique d'épuration des eaux (pp. 689-691).

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*Tassilly*, Étude thermique des iodures anhydres de baryum et de strontium (pp. 733-735). *De Koninck*, Sur les propriétés des sels de nickel et de cobalt (pp. 735-737). *De Forcrand*, Sur les alcoolatés de chaux et de baryte (pp. 737-740). *Rosenstiehl, A.*, Sur les bases ammoniées derivées de l'hexaméthyltriamidotriphénylméthane, et de leur action sur les fuchsines (pp. 740-743). *Delépine*, Sur quelques nouvelles combinaisons de l'hexaméthylèneamine (pp. 743-745).

Tome i. No. 6. *Journal de Pharmacie et de Chimie.* (15th March, 1895.)

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*Berthelot*, Essais pours faire entrer l'argon en combinaison chimique (pp. 345-349). *Hugouneng*, Sur le dosage du sulfate de potasse dans les vins (pp. 349-354). *Denigès, G.*, Essai des médicaments iodés organiques par la méthode cyanimétrique (pp. 354-358). *Hérissey*, De l'inversion du sucre de canne dans quelques sirops acides de la pharmacopée française (pp. 358-361). *Bourquelot*, Réactions d'identité de quelques médicaments galéniques officinaux (361-367).

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*Kohlrausch, F.*, und *Heydweiller, Ad.*, Ueber Widerstandsänderung von Lösungen durch constante electrische Ströme (pp. 385-396). *Warburg, E.*, Ueber electrische Leitung und Convection in schwach leitenden verdünnten Lösungen (pp. 396-434). *Bock, A.*, Ueber das Verhältniss der Quercontraction zur Längendilatation von Eisenstäben bei Magnetisierung (pp. 442-452). *Dahms, A.*, Ueber die Gefrierpunkte einiger binärer Gemenge heteromospher Substanzen (pp. 486-520). *Mebius, C. A.*, Ueber die Glimmentladung in der Luft (pp. 520-544). *Weinstein, B.*, Ueber die Zustands-gleichung der Körper und die absolute Temperatur (pp. 544-576).

Band ccxxxiii. Heft 1. *Archiv der Pharmacie.* (10th March, 1895.)

*Grützner, G.*, Ueber einen krystallisirbaren Bestandteil der *Basanacantha spinosa* var *ferox*. Schum (pp. 1-5). *Schaer, Ed.*, Die Verflüssigung des Choralhydrates mit Phenol und mit Stearoptenen, sowie der letzteren unter sich (pp. 5-26). *Autenrieth, W.*, Ueber die Einwirkung von Phosphorpentachlorid auf aromatische Aether (pp. 26-43). *Autenreith, W.*, Ueber einen neuen Indikator: Luteol (pp. 43-48). *Koch, F.*, Phytochemische Studien. Beiträge zur Kenntniss der mitteleuropäischen Galläpfel, sowie der Scrofularia nodosa. L. (pp. 48-80).

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*Koch, F.*, Phytochemische studien. Beiträge Zur Kenntniss der mitteleuropäischen Galläpfel, sowie der Scrofularia nodosa, L. (pp. 81-100). *Boettinger, C.*, Zur Kenntniss der Glyoxylsäure III. (pp. 100-104). *Zenetti, P.*, Das Vorkommen von Hesperidin in Folia Bucco und seine Krystallformen (pp. 104-111). *Boettinger, C.*, Zur Kenntniss der Glyoxylsäure IV. (pp. 111-118). *Hartwich, C.*, Ueber falsche Senega (pp. 118-125). *Boettinger, C.*, Ueber die Osazone der Zucker aus Sumach und Vallonen (pp. 125-127). *Pommerehne, H.*, Ueber die Alcaloide von Berberis aquifolium (pp. 127-160).

### Jahrgang xxviii. No. 4. *Berichte der Deutschen Chemischen Gesellschaft.* (11th March, 1895.)

*Engler, C.*, Zur Synthese des Indigblaus (pp. 309-312). *Heller, G.*, Ueber die Constitution des Fluorescëens und Eosins (pp. 312-316). *Bredt, J.*, Ueber Camphoronsäure (pp. 316-322). *Reiniger, G.*, und *Schall*, Natriumpresse, modificirt nach Angaben von Hrn. E. Beckmann (pp. 322-324). *Möhlau, R.*, und., *Neubert, A.*, Ueber die Einwirkung von Nitrosodimethylanilin auf tertiäre und secundäre aromatische Amine in Gegenwart von concentrirter Salzsäure (und Formaldehyd) (pp. 324-328). *Zincke, Th.*, Untersuchungen über Azoderivate des Phenyl-β-naphtylamins III. (pp. 328-333). *Marshall, J. W.*, Ueber Benzoësäureazo-β-naphtylphenyl-und p-Tolylamine und deren Oxydationsproducte (pp. 333-340). *Kehrmann, F.*, Uber raumisomere Ester von Chinondioximen (pp. 340-343). *Kehrmann, F.*, Ueber die Einwirkung von Orthoaminophenol auf Orthodiketone (pp. 343-345). *Kehrmann, F.*, und *Mascioni, B.*, Ueber einige Derivate der Jodnaphtalinsäure (pp. 345-353). *Kehrmann, F.*, und *Mascioni, B.*, Ueber einige Oxazinderivate der Naphtalinreihe (pp. 353-360). *Jaubert, G. F.*, Ueber Derivate der Naphtalsäure (1-8-Naphtalindicarbonsäure) (pp. 360-364). *Meyer, V.*, Ueber Calomel (pp. 364-366). *Dühring, U.*, Erklärung, betreffend dié Allgemeingültigkeit des Siedecorrespondenzgesetzes (pp. 366-367). *Will, W.*, Ueber Nitroverbindungen des Naphtalins (pp. 367-379). *Günter, H.*, und *Tafel, J.*, Isomere 2.5-Diaminohexane (pp, 379-385). *Mylius, F.*, Jodstärke und Jodcholsäure (pp. 385-391). *Kahlbaum, G. W. A.*, Notiz über eine äusserst einfache Laboratoriumsschleuder (391-392). *Kahlbaum, G. W. A.*, Apparat zur fractionirten Destillation bei sehr niedrigen Drucken (pp. 392-396). *Fischer, O.*, und *Hepp, E.*, Ueber Fluoresceïnäther (pp. 396-399). *Bamberger, E.*, Zur Kenntniss der Nitrirung organischer Basen (pp. 399-403). *Bamberger, E.*, Ueberführung von Isodiazohydraten in Abkömmlinge des Diphenyls (pp. 403-407). *Anschütz, R.*, und *Beckerhoff, H.*, Nachiveis der Identität von A. Liebmann's Isoamylphenol mit Tertiäramylphenol (pp. 407-410). *Traube, J.*, Methode der Moleculargewichts und Constitutionsbestimmung (pp. 410-419).

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*Uhlmann, P. W.*, Ueber Einwirkung von Cyanessigsäure äthylester auf Mononitrodiazolsäure (pp. 217-234). *Kurnakow, N.*, Ueber complexe Metallbasen (pp. 234-257). *Busch, M.*, Zur Kenntniss der o-Amidobenzylamine I. (pp. 257-285). *Otto, R.*, Beiträge zur Kenntniss der Homologen des Aethylendiphenylsulfons und Aethylenditolylsulfons nebst Mittheilungen über das Verhalten von Mercaptiden gegen Halogenalkylene (pp. 285-316). *Bertram, J.*, und *Kürsten, R.*, Ueber das Vorkommen des Ortho-Cumaraldehydmethyläthers im Cassiaöl (pp. 316-325). *Kym, O.*, Ueber eine neue Bildungsweise secundärer aromatischer Amine (pp. 325-335). *Claus, Ad.*, Zur Geschichte der Bibromsebacinsäure (pp. 335-338). *Claus, Ad.*, Zur sogenannten Tautomerie (pp. 338-344). *Wendt G.*, Zur quantitativen Bestimmung von Condensations produkten (pp. 344-346). *Deninger, A.*, Ueber Versuche zur Darstellung von Kohlenmonosulfid (pp. 346. 350). *Tischendorf, P.*, Zur Kenntniss der Einwirkung von Chlorkohlenoxyd auf einige Derivate von Sulfon-und Sulfinsäuren (pp. 350-352)

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*Brühl, J. W.*, Spektrochemie des Stickstoffs. I. und II. (pp. 193-242). *Zecchini, F.*, Ueber das Brechungsvermögen des Phosphors. III. Brechungsvermögen einiger organischer Verbindungen des Phosphors (pp. 242-244). *Carrara, G.*, Ueber die elektrische Dissociation in ihrer Beziehung zum optischen Drehungsvermögen (p. 244). *Ghira, A.*, Ueber die Darstellung des Bleisesuiäthyls (p. 245). *Ghira, A.*, Weiteres ueber das kryoskopische Verhalten einiger Acetate schwacher Basen (pp. 245-246). *Zecchini, F.*, Ueber das optische Drehungsvermögen des Koniin und seiner Salze (pp. 246-247). *Masini, R.*, Der kritische Koëffizient in Beziehung zu der Formel $\frac{n-1}{d}$ (pp. 248-249). *Stortenbeker, W.*, Ueber Mischkrystalle von Kobaltchlorid und Manganchlorid (pp. 250-261). *Köppe, H.*, Eine neue Methode zur Bestimmung isosmotischer Konzentrationen (pp. 261-289). *Natanson, L.*, Ueber die kinetische Energie der Bewegung der Wärme und die entsprechende Dissipationsfunktion (pp. 289-303). *Schwicker, A.*, Ueber die Umwandlungsgeschwindigkeit des Kaliumhypojodits (pp. 303-315). *Ewan, Th.*, Ueber die Oxydationsgeschwindigkeit von Phosphor, Schwefel und Aldehyd (pp. 315-344). *Rayleigh* und *Ramsay, W.*, "Argon," ein neuer Bestandtheil der Atmosphäre (pp. 344-369). *Crookes, W.*, Ueber das Spektrum des Argons (pp. 369-380). *Olszewski, K.*, Die Ueberführung des Argons in den flüssigen und festen Zustand (pp. 380-384).

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*Peterson, E.*, Die Reaktionsgeschwindigkeit bei der Methylesterbildung (pp. 385-411). *Van T'Hoff, J. H.*, Ueber die Menge und die Natur des sog. Ozons, das sich bei langsamer Oxydation des Phosphors bildet (pp. 411-417). *Pictet, R.*, Ueber Wärmestrahlung bei tiefer Temperatur (pp. 417-450). *Cohen, E.*, Die Wirkung des Wasserstoff auf Bromsilbergelatineplatten (pp. 450-453). *Van T'Hoff, J. H., Cohen, E.*, und *Bredig, G.*, Zur Theorie des Umwandlungs-elements ohne metastabile Phase (pp. 453-458). *Scottländer, P.*, Ueber Reduktion von Wägungen auf den luftleeren Raum (pp. 458-463). *Franke, E.*, Beiträge zur elektrischen Leitfähigkeit von Salzen und Säuren in wässriger

Lösung (pp. 463-493). *Anschutz, R.*, und *Reilter, H.*, Ueber das Drehungsvermögen der Links-Æpfelsäureester (pp. 493-497). *Brühl, J. W.*, Spektrochemie des Stickstoffs III. und IV. (pp. 497-525). *Kuster, F. W.*, Ueber das Wesen isomorpher Mischungen (pp. 525-529). *Rinne, F.*, Die Krystallformen chemisch einfacher Kösper (pp. 529-546). *Noyes, A. A.*, Die Geschwindigkeit der Reaktion zwischen zinnchlonër und Eisenchlorid (pp. 546-562).

Anno xxv. Vol. 1. Fascicolo 2. *Gazetta Chimica Italiana.* (1st March, 1895.)

*Candiani, P.*, Sul trisolfuro die etenile (pp. 81-88). *Filete, M.*, Sul peso molecolare del closuro mercuroso Risposta a V. Meyer (pp. 88-95). *Korner, W.*, Sulla preparazione della ortobibromoanilina [$C_6 . NH_2 . H . Br_2 . H_2$] (pp. 95-97). *Korner, W.* e *Menozzi, A.*, Azione del joduro metilico sulla dimetilasparagina (pp. 97-101). *Marino, Z. F.*, e *Martini, C.*, Presenza della neurina nel sangue (pp. 101-104). *Paladino, P.*, Sopra un nuoro alcaloide contenuto nel caffè (pp. 104-110). *Vignolo, G.*, Sull 'essenza di cannabis indica (pp. 110-115). *Monari, A.* e *Scoccianti, L.*, La piridina dei prodotti della torrefazione del caffè (pp. 115-117). *Purgotti, A.*, Azione dell'idrato d'idrazina sulla cianidrina dell'aldeide benzoica (pp. 117-121). *Seslini, F.*, Composizione chimica della grafitite del monte pisano (pp. 121-124). *Oddo, G.*, e *Curatolo, A.*, Nuovo processo di sintesi degli idrocarburi del gruppo del difenile. Sul p- ed o-feniltolite (pp. 124-136).

# APPENDIX I.

## NOTICES OF BOOKS.

*Allgemeine Physiologie.* Ein Grundriss der Lehre vom Leben. Von Max Verworn. Jena: Gustav Fischer, 1895.

This volume of 571 pages must find a place in the library of every serious student of Nature, for it marks the renaissance of Comparative Physiology. The study of functions, and of structure in relation to the functions, of living plants, animals, and protists, are duly considered, and an attempt is thereupon made to widen the physiological horizon. The kymograph and spirometer would appear to be the author's *bêtes noires*, and of his 268 illustrations, but 10 are tracings and spectral charts, and less than 50 are delineations of apparatus (and those of the simplest possible kind). The rest, with few exceptions, depict living objects and phases of observed activities. The book opens with a Preface, in which the author confesses to an aspiration to a literary style that may appeal to persons beyond the mere craftsmen; and there follows a Historical Sketch, in which the pioneer work of Johannes Müller, to whose memory the book is befittingly dedicated, receives full recognition. Then there follow, in order, Special Chapters devoted to The Constitution and Properties of Living Matter, to Metabolism and Change of Form, The General Conditions of Life, to Stimuli and their Effects, and The Mechanism of Life. The History and Rationale of Life, Cell-division, Reproduction, and Death, are incidentally considered. A considerable portion of the work is devoted to a description and discussion, with extension, of the author's well-known observations upon living protozoa and on the behaviour of the nucleus during functional change. The nucleus is brought into special prominence in relation to protoplasmic movement, the movement of contraction being interpreted as probably due to nuclear attraction. The more important among recent investigations are incorporated, and we note with satisfaction those of Hodge upon the metabolism of the nerve-cell, and of Dreyer and Schulze upon skeletogenesis in the Invertebrata, so fully borne out by the later work of Theel and Kishinouye.

The key to the author's attitude lies in his formidable declamation against the physiological methods of to-day, as inadequate to explain the simplest processes of life. The many and ingenious comparisons between the parts of the animate body and of an inanimate machine, so recently enforced, are now untenable. To take a hackneyed example, the discovery that during the passage of visual stimuli there is a contraction of the retinal pigment, bearing a definite relationship to the colours of the spectrum,[1] and that the image formed by reflection from the posterior face of the crystalline lens comes to a focus within that body,[2] undermine the fascinating comparison of the eye with the photographer's camera. And when we consider, for example, that the evolution of carbonic acid by a living muscle is not a simple respiratory process, but one that under the action of a stimulus may go on in an atmosphere of nitrogen, that the absorption of oxygen by blood does not follow the general law of absorption according to pressure, and that the removal of assimilable food through the intestinal wall does not take place according to the laws deduced from the study of an ordinary diffusion septum, it becomes only too apparent that directly we come into touch with the animate a something has to be reckoned with, which the laws thus far deduced from the study of the inanimate will not explain. What is it that this neo-vitalism presents to us? Is it the Psyche of the ancients over again—a something beyond our discovery or comprehension? or is it a problem in molecular physics? Most assuredly the latter, but not that of the inanimate as thus far understood. The time has come when to the study of the processes of life something more than the application of the methods of the physicist and chemist of to-day to the mere study of organs and tissues must be applied. An entirely new field lies before us. Physiologists have long reminded us that the mystery of life lies hidden in the unicellular organisms, but they have been too fully content to allow their studies to centre in the applied branches of their science. By physiology

[1] Angelucci. Moleschott's *Untersuchg. z. Naturlehre*, bd. xiv., hf. 3.

[2] Boys. *Phil. Mag.* (ser. 5), vol. xiv., p. 40.

we understand the study of the living in action. Verworn, fully realising all this, has boldly taken the initiative, and, studying organisms and the cell, rather than mere organs, availing himself to the utmost of the comparative method, he has laid the foundations of a Modern Physiology. Some of his most cherished views will meet with ready dissent, notably his aforementioned conception of the contractile function; but it is only natural that this should be so. Is function the result of structure, and what are the molecular forces which determine it? The problem remains still unanswered, but that Verworn's method of attacking it is novel and well-founded it must be frankly admitted.

Verworn's Cellular Physiology looms upon us at a time when renewed attempts are being made to apply statistical[1] and experimental methods to the study of the structural variation of animals and plants, and there is something deeply to be regretted in the manner in which advocates of these methods declaim against those of their predecessors and contemporaries. Work, steady work, be it along the "old" or the "new" lines, is what is wanted; and, as in the past, so in the future, with the progressive accumulation of facts there will now and again reveal themselves those, more stupendous than the rest, which, carrying their own refrain, mark the real development of the science, and, stated in generalised form, constitute what is known as a "Law of Nature".

*Lehrbuch der Zoologie.* Von R. Herwtig. Dritte umgearbeitete Auflage. Jena: Gustav. Fischer, 1895.

The third edition of this book is a considerable improvement upon its predecessor, well known and adopted in this country. Of its 585 pp. 146 are devoted to a consideration of the history of zoology and of the general principles of morphology and distribution; and of the 422 pp. which remain 137 are given over to the Vertebrates, and the remainder to the Invertebrates, the great groups being taken in ascending order. In this marked inequality of treatment, and consequent wholesale ignoring of most important animal forms, the author is in the fashion of the times, which counts it more profitable to deal with possibilities (largely deduced from the study of ontogeny) concerning what may have happened in the evolution of living organisms, than to countenance what has happened, as testified by palæontology. Although the Vertebrata are thus inadequately dealt with, important classes of Invertebrata receive scant attention; *e.g.*, the Bryozoa and Brachiopoda, which with the Tunicata (*sic*) are crowded into a Supplement to the Section on Worms. What there is in the book, however, is mostly good, as might be expected; but there is not a little that is behind the times, and that to the well-trained English student is insufficient. *Limulus* is properly placed in proximity to the Trilobites. The Enteropneusta are classed as Vermes, and *Cephalodiscus* and *Rhabdopleura* are not considered. No wonder, therefore, that the grossly conceived "Class Hemichordata" is not upon the list. The author indulges neither in fantastic terminology nor in unwarrantable generalisation, and his book justifies its title, *i.e.*, betokens a laudable desire to present to the student mind a well-arranged digest of what is important in the whole subject with which be deals.

The work is adorned by 568 well-executed illustrations.

*Short Studies in Nature Knowledge.* By William Gee. London: Macmillan & Co., 1895.

The number of small books devoted to the description of natural phenomena is increasing by leaps and bounds, and we often wonder where the flood is to find its limits. It is also a matter of difficulty in the majority of cases to discover the reason why the books ever came into existence, as they serve no useful purpose, and their number simply bewilders the beginner anxious to learn the elementary facts of natural science.

Occasionally, however, there occurs an exception to the rule, and such seems to be the case in the present instance, for the book forming the subject of the present notice, although small, yet contains an immense amount of description calculated not only to instruct, but also to educate.

The more important sections of Physiography are in turn treated in a bright and attractive manner, well calculated to interest and to stimulate further inquiry. The illustrations, as must always be the case in a book like the present, are many of them familiar; nevertheless they are as a whole well selected and to the point, though several of the process blocks compare unfavourably with the woodcuts, and rather make one wish that the progress of photography had not been so rapid.

[1] The term "Mathematical Biology" appears to us an unfortunate misnomer.

Altogether, the book ought to be of use in stimulating a desire for a fuller knowledge of the natural processes going on around us, and, from its bright and interesting character, should be a favourite amongst the cloud of primers of Natural Knowledge.

*Electric Light for Country Houses.* By John Henry Knight. London: Crosby, Lockwood, & Son, 1895.

This is a small manual of under a hundred pages dealing with the problem of lighting country houses by means of electricity. Chapters are devoted to the Dynamo, Motive Power, Fittings, Accumulators, and an important item—Cost. In an appendix are given instructions for working a Dynamo, and an explanation of certain constantly recurring terms. The book is written in a plain and straightforward manner; the explanations are clear and readily understood, and the few illustrations introduced fulfil their purpose.

# APPENDIX II.

## ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN APRIL, 1895.

### Vol. xlix. No. 292. *American Journal of Science.* (April, 1895.)

*Rayleigh* and *Ramsay*, Argon, a New Constituent of the Atmosphere (pp. 275-297). *Trowbridge, J.*, and *Duane, W.*, Velocity of Electric Waves (pp. 297-305).

### Vol. xlix. No. 293. (May, 1895.)

*Lea, M. C.*, Colour Relations of Atoms, Ions and Molecules. I. (pp. 357-374). *Turner, H. W.*, Further Notes on the Gold Ores of California (pp. 374-380). *Linebarger, C. E.*, Some Relations between Temperature, Pressure and Latent Heat of Vaporisation (pp. 380-397). *Pratt, J. H.*, Double Halides of Calcium, Rubidium, Sodium and Lithium with Thallium (pp. 397-405). *Hill, E. A.*, Argon, Prout's, Hypothesis and the Periodic Law (pp. 405-417).

### Vol. xvii. No. 4. *American Chemical Journal.* (April, 1895.)

*Rayleigh* and *Ramsay*, Argon, a New Constituent of the Atmosphere (pp. 225-251). *Crookes, W.*, On the Spectra of Argon (pp. 251-262). *Olszewski, K.*, The Liquefaction and Solidification of Argon (pp. 262-267). *Morley, E. W.*, On the Atomic Weight of Oxygen. Syntheses of Weighed Quantities of Water from Weighed Quantities of Hydrogen and Oxygen (pp. 267-275). *Stokes, H. N.*, On the Chloronitrides of Phosphorus (pp. 275-290). *Kastle, J. H.*, and *Murril, P.*, On the Saponification of the Ethers of the Sulphuric Acids by Alcohols (pp. 290-297). *Richards, T. W.*, and *Oenslager, G.*, On the Cupri-ammonium Double Salts (pp. 297-305). *Wiechmann, F. G.*, Basswood Oil (pp. 305-308).

### Vol. xvii. No. 5. (May, 1895.)

*Remsen, I.*, and *Coates, C. E.*, The Action of Aniline and of the Toluidines on Orthosulphobenzoic Acid and its Chloride (pp. 311-330). *Remsen, I.*, and *Kohler, E. P.*, Further Study of the Action of Aniline in the Chlorides of Orthosulphobenzoic Acid (pp. 330-347). *Remsen, I.*, and *Saunders, A. P.*, Separation of the Two Chlorides of Orthosulphobenzoic Acid (pp. 347-368). *Stone, W. E.*, and *Lotz, D.*, The Sugar of the *Agave Americana* (pp. 368-372). *Trevor, J. E.*, The Law of Mass Action (pp. 372-374). *Palmer, C.*, Chromates of the Rare Earths, Chromates of Thorium (pp. 374-379). *Cushman, A. S.*, On a New Method for the Separation of Copper and Cadmium in Qualitative Analysis (pp. 379-383).

### Vol. xvii. No. 5. *Journal of the American Chemical Society.* (May, 1895.)

*Thomas, W. S.*, Methods for the Determination of Manganese (pp. 341-346). *Dulin, R. S.*, The Wet Assay for Copper (pp. 346-351). *Shiver, F. S.*, On the Standardisation of Sulphuric Acid (pp. 351-354). *Linebarger, C. E.*, On Some Experiments in the Anthracene Series (pp. 354-358). *Linebarger, C. E.*, On the Reaction between Zinc Sulphate and Potassium Hydroxide (pp. 358-360). *Bachman, I. A.*, Chemical Brick for Glover Towers (pp. 360-361). *Norton, T. H.*, The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagration (pp. 361-381). *Ehrenfeld, C. H.*, A Study of the Chemical Behaviour of Tungsten and Molybdenum and their Trioxides (pp. 381-397). *Gladding, T. S.*, The Determination of Sulphur in Pyrites, A Reply to Dr. Lunge (pp. 397-402). *Horton, H. E.*, Acidity of Glucose Syrup and Grape Sugar (pp. 402-403). *Horton, H. E.*, Ash in Glucose Syrup and Grape Sugar (pp. 403-405). *Mixer, C. T.*, and *Du Bois, H. W.*, The Zimmermann-Reinhardt Method for the Determination of Iron in Iron Ores (pp. 405-411). *Blomén. J. E.*, On the Manufacture of Soluble Nitrocellulose for Nitrogelatine and Plastic Dynamites (pp. 411-419).

### Vol. xx. No. 229. *The Analyst.* (April, 1895.)

*Dupré, A.*, Note on the Chemical and Bacteriological Examination of Water, with Remarks on the Fever Epidemic at Worthing in 1893 (pp. 73-80). *Thresh, J. C.*, The Interpreta-

tion of the Results obtained upon the Chemical and Bacteriological Examination of Potable Water (pp. 80-91).

Vol. xx. No. 230. (May, 1895.)

*Thresh, J. C.*, The Interpretation of the Results obtained upon the Chemical and Bacteriological Examination of Potable Waters (pp. 97-111). *Cameron, C. A.*, Note on Unusual Specimens of Milk (p. 111).

Vol. lxvii. No. 390. *Journal of the Chemical Society.* (May, 1895.)

*Kipping, F. S.*, and *Pope, W. J.*, π-Halogen Derivatives of Camphor (pp. 371-399). *Sedgwick A. P.*, and *Collie, N.*, Some Oxypyridine Derivatives (pp. 399-413). *Perkin, A. G.*, and *Hummel, J. J.*, The Colouring Principle of *Toddalea aculeata* and *Evodia meliaefolia* (pp. 413-416). *Bone, W. A.*, and *Perkin, W. H., Junr.*, Trimethylsuccinic and αα-Dimethylglutaric Acids (pp. 416-433). *Cross, C. F., Bevan, E. J.*, and *Beadle, C.*, Contributions to the Chemistry of Cellulose (pp. 433-452). *Divers, E.*, and *Haga, T.*, Potassium Nitrososulphates (pp. 452-459). *Dunstan, W. R.*, and *Carr, F. H.*, The Constitution of Aconitine, Acetyl Derivatives of Benzaconine and Aconitine (pp 459-467).

Vol. xiv. No. 4. *Journal of the Society of Chemical Industry.* (30th April, 1895.)

*Gray, G. W.*, The Estimation and Numerical Expression of Colour in Tanning Materials (pp. 335-336). *Darby, J. H.*, The Semet-Solvay Coke Oven (pp. 336-340). *Brookman, F. W.*, Utilisation of Town Refuse at Rochdale (pp. 340-343). *Hogg, T. W.*, Immunity of Some Low Forms of Life from Lead Poisoning (p. 344). *Hogg, T. W.*, On Two Interesting Cases of Abnormal Condition in Pig Iron (pp. 344-345). *Prof. Clowes* and *Fielmann, M. E.*, The Extinctive Atmospheres Produced by Flames (pp. 345-346). *Heal, C. B.*, and *Procter, H. R.*, The Analysis of Liquors Used in Chrome Tannage (p. 347). *Stebbins, J. H.*, Note upon the Identification of a Certain Red Azo-Colouring Matter (pp. 347-349). *Sherer, E.*, Commercial Methods for the Valuation of Imported Sugars applied to the Assessment of Duties thereon (pp. 349-351).

Vol. xxxix. No. 240. *Philosophical Magazine and Journal of Science.* (May, 1895.)

*Skinner, S.*. The Tin-Chromic Chloride Cell (pp. 444-447). *Evershed, J.*, Experiments on the Radiation of Heated Gases (pp. 460-476). *Soret, C.*, On the Rotational Co-efficient of Thermal Conductivity in Crystals (p. 476).

Vol. lvii. No. 343. *Proceedings of the Royal Society.* (6th April, 1895.)

*Griffiths, E. H.*, The Latent Heat of Evaporation of Water (pp. 212-224).

Series 7. No. 5. *Annales de Chimie et de Physique.* (May, 1895.)

*Pellat, H.*, Électrostatique non fondée sur les lois de Coulomb. Forces électriques agissant à la surface de séparation de deux diélectriques (pp. 5-99). *Topin, J.*, Sur quelques nouveaux sels d'amide (pp. 99-132).

Tome xiii.-xiv. No.8. *Bulletin de la Société Chimique de Paris.* (20th April, 1895.)

*Barral, Et.*, Constitution de l'hexachlorophénol-α et de la quinone (pp. 423-427). *Barral, Et.*, Sur le parabichlorure de benzène hexachloré (pp. 418-423). *Battandier*, Réaction de la chélidonine avec les phénols en solution sulfurique (pp. 446-447). *Besson, A.*, Sur le chlorobromure et le bromure de carbonyle (pp. 444-445). *Cambier, R.*, et *Brochet, A.*, Action de l'aldéhyde formique sur les amines et leurs sels (pp. 392-418). *Franchimont, A. P. N.*, Sur une nouvelle classe de dérivés de l'urée (p. 445). *Reychler, A.*, Les sels d'argent ammoniacaux (pp. 386-392). *Rosenstiehl, A.*, Les fuchsines sont-elles des éthers on des sels? (pp. 431-433). *Rosenstiehl, A.*, Sur les propriétés basiques des rosanilines et de leurs dérivés sulfonés. Réponse à M. Prud'homme (pp. 427-430). *Thomas, V.*, Sur une combinaison cristallisée de chlorure ferreux avec le bioxyde d'azote (pp. 385-386). *Winter, J.*, De l'analyse du suc gastrique (pp. 433-441). *Jay* et *Dupasquier*, Sur la fabrication du phosphate de potasse (pp. 441-443). *Joffre, J.*, Note sur l'humus (pp. 443-444).

Tome xiii.-xiv. No 9. (5th May, 1895.)

*Barral, E.*, Sur trois octochlorphénols (trichlorures de pentachloro-cyclo-hexa-diène-one) (pp. 490-492). *Barthe, L.*, Sur le dosage volumétrique du zinc (pp. 472-473). *Bruylants*, Réactions nouvelles de la morphine (pp. 497-500). *Cazeneuve, P.*, Recherches sur la stérilisation du lait et la fermentation lactique (pp. 502-509). *Cazeneuve, P.*, et *Haddon, E.*, Sur l'infidélité des crémomètres pour apprécier la matière grasse dans les laits pasteurisés (pp. 500-502). *Delépine*, Chloromercurates et iodomercurates d'hexaméthylène-amine (pp. 494-497). *Delépine*, Hexaméthylène-amine. Action du chlorhydrate de phényl-hydrazine (pp. 492-494). *Dufet, H.*, Sur les ferrocyanure, ruthéniocyanure et osmio-cyanure de potassium (p. 511). *Duvillier, E.*, Sur l'acide diméthylamido-α-caproique (pp. 484-487). *Duvillier, E.*, Sur l'éthylhydantoïne-propionique (pp. 487-490). *Forcrand de*, Sur l'éthylate de calcium (p. 512). *Guy, P. A.*, et *Gautier*, Superposition des effets optiques des divers carbones asymétriques dans une même molécule active. II. (pp. 457-464). *Guye, P. A.*, et *Rossi, B.*, Contribution á l'étude de la dissociation des sels actifs en solution (pp. 464-469). *Jean, F.*, Préparation de l'ethylamine par la réduction de l aldehyde d'ammoniaque (p. 474). *Pictet, A.*, et *Hubet, A.*, Sur un procédé de synthese de la phénantridine et de ses derivés (p. 512). *Simon, L.*, Action des amines aromatiques primaires sur les composés cétoniques dissymétriques (pp. 474-484). *Tanret, C.*, Sur l'état amorphe des corps fondus (pp. 454-457). *Tasilly*, Etude thermiques des iodures anhydres de baryum et de strontium (pp. 449-451). *Varet, R.*, Recherches sur les chaleurs de combinaison du mercure avec les éléments (pp. 451-454). *Vaudin, L.*, Sur le phosphate de chaux du lait (pp. 469-471). *Prud'homme, M.*, Sur le mordant de glucine (pp. 509-511).

Tome cxx. No. 13. *Comptes Rendus hebdomadaires de l'Académie des Sciences.* (1st April, 1895.)

*Dehérain, P. P.*, Sur la composition des eaux de drainage (pp. 701-707). *Maze*, Sur le premier thermomètre à mercure (pp. 732-733). *Tassilly*, Étude thermique des iodures anhydres de baryum et de strontium (pp. 733-735). *De Koninck*, Sur les propriétés des sels de nickel et de cobalt (pp. 735-737). *De Forcrand*, Sur les alcoolates de chaux et de baryte (pp. 737-740). *Rosenstiehl, A.*, Sur les bases ammoniées, dérivées de l'hexaméthyl triamidotriphenylméthane, et de leur action sur les fuchsines (pp. 740-743). *Delépine*, Sur quelques nouvelles combinaisons de l'hexaméthylène-amine (pp. 743-745).

Tome cxx. No. 14. (8th April, 1895.)

*Guntz*, Sur une expérience simple montrant la présence de l'argon dans l'azote atmosphérique (pp. 777-778). *De Gramont, A.*, Sur les spectres du sélénium et de quelques séléniures (pp. 778-781). *Denigès, G.*, Sur le dosage du thiophène dans la benzine (pp. 781-783). *Maumené, E.*, De l'action du permanganate de potasse avec diverses matières organiques (pp. 783-785). *Vaudin, L.*, Sur le phosphate de chaux du lait (pp. 785-787).

Tome cxx. No. 15. (16th April, 1895.)

*Berthelot*, Observations sur le argon : spectre de fluorescence (pp. 797-801). *Gréhant, N.*, Sur les produits de combustion de l'arc électrique (pp. 815-816). *Berthelot, D.*, Sur une nouvelle méthode pour la mesure des températurs (pp. 831-834). *Clève, P. F.*, Sur la présence de l'hélium dans la clévéite (pp. 834-835). *Le Chatelier, H.*, Sur les combinaisons définies des alliages métalliques (pp. 835-837). *Henry, L.*, Sur les aldéhydes aliphatiques C $H_{2n}$ O (pp. 837-840). *Cousin, H.*, Action des halogènes sur la pyrocatéchine (pp. 840-842).

Tome cxx. No. 16. (22nd April, 1895.)

*De Launoy, S.*, Sur la dilatation de l'eau (pp. 866-868). *Violle, J.*, Chaleur spécifique et point d' ébullition du carbone (pp. 868-869). *Branly, E.*, Résistance électrique au contact de deux métaux (pp. 869-872). *Pionchon, J.*, Sur une méthode optique d'etude des courrants alternatifs (pp. 872-875). *Lumière, A.*, et *L.*, Sur la photographie en couleurs naturelles par la méthode indirecte (pp. 875-876). *Guye, P. A.*, Rotation moléculaire et déviation moléculaire (pp. 876-878). *Ville, J.*, et *Astre, C.*, Sur quelques derivés de l'acide quinone-di-o-amino- benzoïque (pp. 878-880).

Tome cxx. No. 17. (29th April 1895.)

*Varet, R.*, Nouvelles recherches sur les chaleurs de combinaison du mercure avec les éléments (pp. 921-923). *Granger, A.*, Sur l'action des combinaisons halogénées du phosphore sur le cuivre métallique (pp. 923-924). *Lepierre, C.*, Recherches sur le manganèse (pp. 924-927). *Béhal, A.*, Amides et acides campholéniques (pp. 927-930). *Perrier, G.*, Combinaisons doubles du chlorure d'aluminium anhydre avec les composés nitrés appartenant à la série aromatique (pp. 930-933). *Lafon, P.*, De l'erreur qu' on peut commettre, par l'emploi de la liqueur de Fehling, pour la recherche du sucre dans les urines des personnes soumises au traitement du sulfonal (pp. 933).

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*Stoehr, C.*, Ueber Pyrazine und Piperazine IV. (pp. 449-477). *Claus, Ad.*, und *Caroselli, A.*, Ortho-para-Dibromchinolin (pp. 477-490). *Claus, Ad.*, und *Wolf, F.*, Ortho-anadibromchinolin (pp. 490-498). *Filete, M.*, und *Ponzio, G.*, Umwandlung der ketone in α-Diketone (pp. 498-510). *Niementouski, M. von*, Derivate des m-Methyl-o-Uramidobenzoyls (pp. 510-517). *Otto, R.*, und *Mühle, K.*, Beitrag zur Frage der Analogie im Verhalten von Halogenalkylen gegen Natrium und ähnlich wirkende Metalle einerseits und Mercaptide andererseits (pp. 517-522). *Rothenburg, R. v.*, Zur Constitutionsfrage der n-Phenylpyrazolone (pp. 522-526). *Haeussermann, C.*, und *Teichmann, H.*, Zur Kenntniss der Diamidobenzoësäuren (pp. 526-528). *Walther, R.*, Ueber die Constitution

der Diazobenzolverbindungen (pp. 528-532). *Himmelbauer, R.*, Zur Kenntniss der Pyrazolonderivate (p. 532).

Band xvi. Heft 3. *Monatshefte für Chemie und Verwandte Theile Anderer Wissenschaften.* (March, 1895.)

*Brunner, K.*, Eine neue Beldungsweise des Pr. 2, 3-Dimethylindols (pp. 183-190). *Haiser, F.*, Zur Kenntniss des Inosinsäure (pp. 190-207). *Knoll, R. J.*, und *Cohn, P.*, Ueber o-Bromphenylnaphtylketon (pp. 207-211). *Lieben, Ad.*, Ueber Reduction der Kohlensäure bei gewöhnlicher Temperatur (pp. 211-248). *Oettinger, K.*, Ueber die Umwandlung des Triamidophenols in 1, 2, 3, 5-Phentetrol (pp. 248-260). *Oettinger, K.*, Zur Kenntniss der Acetylproducte des Triamidophenols (pp. 260-265).

Band xvi. Heft 4. (April, 1895.)

*Cohn, P.*, Zur Kenntniss des o-Phenobenzylamins und des Cyclophenylenbenzylidenoxyds (pp. 267-283). *Welbel, B.*, und *Zeisel, S.*, Ueber die Condensation von Furfurol mit Phloroglucin und eine auf diese gegründete Methode der quantitativen Bestimmung des Furfurols aus Pentosen und Pentosanen I. (pp. 283-312). *Herzig, J.*. Studien ueber Quercitin und seine Derivate XI. (pp. 312-321). *Konek, F. v.*, Ueber Hydrirungsversuche mit Cinchonin (pp. 321-333). *Kohn, E.*, Einige Derivate der Galaktonsäure (pp. 333-343).

Band ix. Heft 1. *Zeitschrift für Anorganische Chemie.* (25th May, 1895.)

*Berthelot*, Ueber das Fluoreszenzspektrum des Argons und ueber seine Beziehungen zum Nordlicht (pp. 4-6). *Straus, P.*, Beitrag zur Kenntnis der Kupfer und Mangancyanide (pp. 6-19). *Pratt, J. H.*, Ueber Doppelhalogen-verbindungen von Cäsium, Rubidium, Natrium und Lithium mit Thallium (pp. 19-29). *Arctowski, H.*, Ueber die Flüchtigkeit des Chromsäureanhydrides (29-31). *Roessler, F.*, Synthese einiger Erzmineralien und analoger Metallverbindungen durch Auflisen und Kyrstalliscerenlassen derselben in geschmolzenen Metallen (pp. 31-78). *Engels, C.*, Vorläufige Mitteilung (pp. 78-79).

Band xvi. Heft 4. *Zeitschrift für Physikalische Chemie.* (30th April, 1895.)

*Retgers J. W.*, Beiträge zur Kenntniss des Isomorphismus. XI. (pp. 577-659). *Zepernick, K.*, und *Tammann, G.*, Ueber die Volumina einiger wässeriger Salzlösungen zwischen 100 and 150° (pp. 659-671). *Rimbach, E.*, Dissociation und optische Drehung aktiver Salzlösungen (pp. 671-677). *Luggin, H.*, Ueber die Kapillarelektrishen Erscheinunglen (pp. 677-708). *Trübsbach, P. A.*, Die Affinitätsgrössen der Ureïde und Isonitrosoderivate (pp. 708-729). *Bodländer, G.*, Ueber die Löslichkeit einiger Stoffe in Gemischen von Wasser und Alkohol (pp. 729-731). *Knietsch, R.*, Die kritische Temperatur als Kriterium der Chemischen Reinheit (pp. 731-746).

Band xvii. Heft 1. (28th May, 1895.)

*Hoitsema, C.*, Palladium und Wasserstoff (pp. 1-43). *Natanson, L.*, Ueber die kritische Temperatur des Wasserstoffes (pp. 43-49). *Van T' Hoff, J. H., Goldschmidt, H.*, und *Jorissen, W. P.*, Ueber die Spaltung der Traubensäure und das Racemat von Scacchi (pp. 49-62). *Coggeshall, G. W.*, Ueber die Konstanz der Kalomel-Elektrode (pp. 62-87). *Morley, E. W.*, Ueber das Verhältnis des Atomgewichtes von Wasserstoff und Sauerstoff (pp. 87-107). *Beckmann, E.*, und *Stock, A.*, Beiträge zur Bestimmung von Molekulargrössen. II. pp. (107-136). *Andrews, L. N.*, und *Eride, C.*, Eine Studie der physikalischen Eigenschaften von Chlorlithiumlösungen in Amylakohol (pp. 136-145). *Goldschmidt, H.*, Die molekulare Löslichkeitserhöhung. I. (pp. 145-164). *Hedin, S. G.*, Ueber die Bestimmung isosmotischer Konzentrationen durch Zentrifugieren von Blutmischungen (pp. 164-171). *Bakker, G.*, Zusammenhang zwischen den Gesetzen von Mariotte, Gay-Lussac und Joule. II. (pp. 171-191).

Anno xxv. Vol. 1. Fascicolo 4. *Gazetta Chimica Italiana.* (4th May, 1895.)

*Filete, M.*, e *Ponzio, G.*, Trasformazione dei chetoni in α-dichetoni (pp. 233-245). *Jaubert, G. F.*, Ricerche sull acido naftalico (1.8 naftalin-dicarbonico) e suoi derivate (pp. 245-255). *Marino-Zuco, F.*, Sulla crisantemina (pp. 255-262). *Marino-Zuco, F.*, e *Vignolo, G.*,

Sopra gli alcaloidi della cannabis indica e della cannabis sativa (pp. 262-269). *Tarugi, N.*, Preparazione pratica dell 'acido tioacetico e suo uso in tossicologia (pp, (269-274), *Rayleigh*, e *Ramsay, W.*, L'Argo, nuovo componente dell 'atmosfera (traduzione fatta col consenso degli auton da Naseni R.) (pp. 274-310). *Scacchi, E.*, Studio cristallografico di alcuni acidi fenilnitro-cinnamici ($C_{15}H_{11}NO_4$) e loro derivati (pp. 310-327). *Oddo, G.*, Sulla massima temperatura di formazione e la temperatura di decomposizione di alcuni cloruri di diazocomposti della serie aromatica (pp. 327-339).

# APPENDIX I.

## NOTICES OF BOOKS.

*Agriculture, Practical and Scientific.* By James Muir, M.R.A.C., Professor of Agriculture in the Yorkshire College, Leeds. London: Macmillan & Co., 1895.

Anything which will give the farmer a better chance of making agriculture profitable will always receive a warm welcome in England, and certainly one of the most promising signs of the times is the increasing tendency to study the scientific principles underlying the ordinary operations of the farm.

Unfortunately a considerable period must elapse before such study becomes general, for the average farmer, besides having little time to devote to reading scientific books, as a rule possesses so little knowledge of the elementary principles involved that he would find it difficult to make much progress unless he were fortunate enough to be able to obtain help from some one more familiar with scientific subjects.

In the future, when, it may be hoped, scientific and technical education will be more general, students of agriculture will undoubtedly be in a better position to make the best of things and will be able to call to their aid processes of which their predecessors of to-day know nothing.

It is to the younger generation of agriculturists that we must look for progress, and it is to these that Professor Muir's book will be especially useful, for to anybody armed with a slight but accurate knowledge of science, the clear and methodical treatment of the various heads of the subject must be of immense help. The first chapters are devoted to a consideration of the plant, the soil and its formation and the classification of soils, the plant food in the soil, and the soil's losses and gains. Then follows a chapter on the British geological formations and their agricultural characteristics, and next is treated the subject of improvement of the soil by drainage, irrigation, mixing soils, and liming. Manuring is treated in five chapters. One chapter is devoted to implements and machinery, and the next ten or twelve chapters are devoted to the subject of crops and cropping, most of the crops being treated at some length, and information given as to the varieties usually grown. Directions are also given for the preparation of the seed-bed most suitable for each plant, and the treatment necessary to bring the crop to perfection is described at some length. Finally some pages are devoted to the diseases and insect pests attacking crops, and the best means of dealing with these.

Altogether the descriptions are full and lucid and much valuable information is to be gained by a study of the book. The illustrations and general get-up are excellent.

*Lessons in Elementary Physics.* By Balfour Stewart, M.A., LL.D., F.R.S. New and enlarged edition. London: Macmillan & Co., 1895.

The appearance of the present (the fourth) edition of this familiar and ever useful text-book makes one glance back at the period which has elapsed since its first appearance in 1870. Some idea of the favour with which it was received may be gathered from the fact that the first edition was reprinted in 1871, 1873, 1874, 1875, and 1877. The second edition appeared in 1878, and was reprinted 1879, 1880, 1881, 1882, 1883, January and November, 1884, 1885, 1886, 1887, and January, 1888. The third edition appeared in June, 1888, and was reprinted in 1891, and the fourth and present edition has just been published. Successive editions have in turn been improved and enlarged, and at present the book is one which students would be sorry to be without. All beginners in Physics should be grateful to Mr. W. W. Haldane Gee for the trouble he has taken in bringing the present edition up to date.

*The Natural History of Aquatic Insects.* By Professor L. C. Miall, F.R.S. London: Macmillan & Co., 1895.

One of the greatest evils of modern specialism in science is the increasing disinclination on the part of animal morphologists and botanists to study the forms with which they are concerned in the living state and in the open air. Perhaps the argument made use of is that the functions of the organisms, and their manner of life, concern more the physiologist than

the morphologist, and that the morphologist has more than enough to do in studying the details of structure in the laboratory.

True as this may be it is much to be regretted that many of the younger students of morphological science are wofully ignorant of out-of-door life, and seem to be almost entirely devoid of that love of nature which was a characteristic feature of the older naturalists.

Professor Miall's book on the Natural History of Aquatic Insects is written in such a manner as to appeal to all naturalists, and more especially to young naturalists. It will lead them on through pleasant paths, and by enjoyable lessons will teach them much that is worth knowing with regard to the habits and structure of the members of one of the most interesting assemblages of living beings. In addition to lucid and accurate descriptions there are provided numerous admirably drawn figures, in some cases taken from the works of the older naturalists but many of them drawn directly from the actual insects. Certainly the author ought to succeed in his endeavour to "revive an interest in the writings of certain old zoologists —Swammerdam, Réaumur, Lyonnet, and De Geer—who are at present unjustly neglected". We can thoroughly recommend the book.

# APPENDIX II.

## ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN JUNE, 1895.

Vol. l. No. 295. *American Journal of Science.* (July, 1895.)

*Wells, H. L.*, Compounds containing Lead and extra Iodine (pp. 21-27). *Gooch, F. A.*, and *Fairbanks, C.*, Estimation of the Halogens in Mixed Silver Salts (pp. 27-33). *Gooch, F. A.*, and *Clemons, C. F.*, Determination of Selenious Acid by Potassium Permanganate (pp. 51-55).

Vol. xvii. No. 7. *American Chemical Journal.* (July, 1895.)

*Edwards, W. F.*, Some Notes on Molecular and Atomic Refraction (pp. 473-507). *Hite, H. B.*, A New Apparatus for Determining Molecular Weights by the Boiling-point Method (pp. 507-517). *Orndorff, W. A.*, and *Cameron, F. K.*, A New Apparatus for the Determination of Molecular Weights by the Boiling-point Method (pp. 517-532). *Seldner, R.*, Glutarimide (pp. 532-535). *De Chalmot, G.*, On the Oxidation of Complex Carbohydrates (pp. 535-539). *Jones, H. C.*, On the Determination of Formic Acid by Titration with Potassium Permanganate (pp. 539-541).

Vol. xx. No. 232. *The Analyst.* (July, 1895.)

*Hehner* and *Mitchell*, A New Thermal Method for the Examination of Oils (pp. 146-152) *Bevan, E. J.*, The Use of Formalin as a Preservative of Milk Samples (pp. 152-154). *Richmond* and *Boseley*, Note on the Detection of Formalin (pp. 154-157). *Rideal, S.*, On Formalin as a Milk-Preservative (pp. 157-159). *Young, W. C.*, A Comparison of the Organic Carbon and Nitrogen Results obtained by Dr. Frankland and the Companies' Analysts from the Waters supplied by the Metropolitan Water Companies (pp. 159-164).

Vol. lxvii. No. 392. *Journal of the Chemical Society.* (July, 1895.)

*Brauner, B.*, On the Atomic Weight of Tellurium (pp. 549-552). *Rose, T. K.*, Note on Liquation in Crystalline Standard Gold (pp. 552-556). *Dixon, A. E.*, Substitution-derivatives of Urea and Thiourea (pp. 556-565). *Dixon, A. E.*, and *Doran, R. E.*, Derivatives of Succinyl and Phthalyl Dithiocarbimides (pp. 565-576). *Walker, J.*, and *Aston, E.*, Affinity of Weak Bases (pp. 576-587). *Sudborough, J. J.*, Diortho-substituted Benzoic Acids. I. Substituted Benzoyl Chlorides (pp. 587-601). *Sudborough, J. J.*, Diortho-substituted Benzoic Acids. II. Hydrolysis of Aromatic Nitriles and Acid-amides (pp. 601-604). *Sudborough, J. J.*, Note on the Action of Sodium Ethoxide on Deoxybenzoïn (pp. 604-606). *Ingle, H.*, and *Mann, H. H.*, Stereoisomeric Osazones. I. (pp. 606-616). *Purdie, T.*, and *Walker, J. W.*, Preparation of the Active Lactic Acids and the Rotation of their Metallic Salts in Solution (pp. 616-640). *Herzfelder, A.*, The Interaction of Sulphur and α-Nitronaphthalene (pp. 640-644). *Perkin, A. G.*, and *Pate, L.*, Acid Compounds of some Natural Yellow Colouring Matters (pp. 644-653). *Chattaway, F. D.*, ββ-Naphthyl and its Quinones (pp. 653-664). *Pickering, S. U.*, A Comparison of some Properties of Acetic Acid and its Chloro- and Bromo-derivatives (pp. 664-684). *Ramsay, W.*, *Collie, J. N.*, and *Travers, M. W.*, Helium, a Constituent of Certain Minerals (pp. 684-701).

Vol. xiv. No. 6. *Journal of the Society of Chemical Industry.* (29th June, 1895.)

*Hart, P.*, On the Treatment of Zinc Ores and Complex Ores containing Zinc (pp. 544-546). *Irwin, W.*, The Chemical Constitution of Gas Enrichers, and its Relation to their Enriching Value (pp. 546-551). *Gerland, B. W.*, On Kuhlmann's Balances with Mirror-reading (pp. 551-552). *O'Sullivan, J.*, Note on the Hydrolysis and Estimation of Sugar (pp. 555-556). *Schüpphaus, R. C.*, The Evolution of Smokeless Powder (pp. 556-559).

Vol. xl. No. 242. *Philosophical Magazine and Journal of Science.* (July, 1895.)

*Sutherland, W.*, The Fundamental Atomic Laws of Thermochemistry (pp. 1-56). *Herroun, E. F.*, On the Use of an Iodine Voltameter for the Measurement of Small Currents (pp. 91-95). *Wildermann, M.*, Experimental Proof of Van't Hoff's Constant, of Arrhenius's Generalisation, and of Ostwald's Law of Dilution in very Dilute Solutions (pp. 119-144).

Tome v. *Annales de Chimie et de Physique.* (July, 1895.)

*Curie, P.*, Propriétés magnétiques des corps à diverses températures (pp. 289-405). *De Forcrand*, Recherches thermochimiques sur l'acide éthylacétylacétique (pp. 405-418). *Neyreneuf*, Recherches sur les tuyaux sonores (pp. 418-429). *Berthelot* et *André, G.*, Sur la présence de l'alumine dans les plantes et sur sa répartition (pp. 429-432).

Tomes xiii.-xiv. No. 12. *Bulletin de la Société Chimique de Paris.* (20th June, 1895.)

*Bordas, E.*, et *Girard C.*, Procéde chimique d'épuration des eaux (667-668). *Burcker, E.*, Dosage des acides dans les vins (pp. 644-647). *Causse, H.*, Dosage de l'azote organique par le procédé de Kjeldahl, en l'absence des nitrates (pp. 636-642). *Dastre, A.*, Transformation de la fibrine par l'action prolongée des solutions salines faibles (pp. 665-666). *De Forcrand*, Sur les alcoolates de chaux et de baryte (pp. 657-659). *Gérard, E.*, Sur l'acide daturique (pp. 663-664). *Jay, H.*, Sur l'acidité volatile des vins (pp. 642-644). *Le Chatelier, H.*, Sur la chaleur de formation de quelques composés du fer (pp. 647-649). *Lespieau, R.*, Sur quelques dérivés des bromures en $C_3$ (pp. 629-632). *Livache, A.*, Sur la siccativité des matières grasses en général et leur transformation en produits élastiques analogues a la linoxine (pp. 671-672). *Pagnoul*, Recherches sur l'azote assimilable et sur ses transformations dans la terre arable (pp. 668-671). *Rabaut, C.*, Sur la benzinesulfo-orthotoluidine et quelques dérivés (pp. 633-636). *Richard, J.*, Sur les gaz de la vessie natatoire des poissons (pp. 666-667). *Rivals, P.*, Sur le polymère cristallisé de l'aldéhyde monochlorée (p. 663). *Rivals, P.*, Sur les aldéhydes chlorées (pp. 661-663). *Rivals, P.*, Sur les chlorures acides et les aldéhydes chlorées (pp. 660-661). *Ruizand, L.*, Sur deux réactions pratiques permettant de différencier le lactose du glucose (p. 665). *Schutzenberger, P.*, Recherches sur les métaux de la cérite (pp. 649-657).

Tome xiii.-xiv. No. 13. (July 5th, 1895.)

*Berlemont, G.*, Noveau tube à distillations fractionnées modifié par M. Lebel (pp. 674-675). *Varet, R.*, Nouvelles recherches sur les chaleurs de combinaison du mercure avec les éléments (pp. 675-677). *Varet, R.*, Sur les transformations isomériques des sels de mercure (pp. 677-678). *Dupasquier, J.*, Procédé de séparation de la chaux d'avec la strontiane ou la baryte (pp. 678-681). *Brochet, A.*, Action des halogènes sur l'alcool méthylique (pp. 681-689). *Trillat, A.*, Préparation des amines de la série grasse (pp. 689-692). *Georges*, Recherche de l'alunage des vins (692-696). *Dupont, J.*, Sur l'existence d'une matière sulfurée dans l'huile de coton (pp. 696-697). *Joffre, J.*, Note sur l'emploi des superphosphates (pp. 698-703). *Halphen, G.*, Exposé de quelques points relatifs à l'analyse de corps gras (pp. 703-745).

Tome cxx. No. 23. *Comptes Rendus hebdomadaires de l'Académie des Sciences.* (10th June, 1895.)

*Deslandres, H.*, Étude spectrale des charbons du four électrique (pp. 1259-1260). *Villard, P.*, Propriétés physiques de l'acétylène; hydrate d'acétylène (pp. 1262-1265). *Henry, L.*, Formation synthétique d'alcools nitrés (pp. 1265-1269). *Barbier P.*, et *Bouveault, L.*, Condensation des aldéhydes et des acétones saturées (pp. 1269-1272). *Cazeneuve, P.*, et *Haddon*, Sur les causes de la coloration et de la coagulation du lait par la chaleur (pp. 1272-1274). *Guye, Ph. A.*, et *Jordan*, C., Ethers des acides $\alpha$-oxybutyriques actifs (pp. 1274-1276). *Battandier*, Sur l'histoire des alcaloïdes des Fumariacées et Papavéracées (p. 1276). *Schloesing, T., fils*, Contribution à l'étude de la germination (pp. 1278-1281). *Effront*, Sur l'amylase (pp. 1281-1283).

Tome cxx. No. 24. (17th June, 1895.)

*Janssen*, Note sur la loi d'absorption des bandes du spectre de l'oxygène (pp. 1306-1310) *Berthelot*, Sur la combinaison de l'azote libre avec les éléments du sulfure de carbone (pp. 1315-16). *Berthelot*, Nouvelle combinaison de l'argon; synthèse et analyse (pp. 1316-

1320). *Moissan, H.*, Préparation et propriétés du molybdène pur fondu (pp. 1320-1326). *Haller, A.*, Action de l'isocyanate de phényle sur les acides campholiques, carboxyl-campholique et phtalique (pp. 1326-1329). *Recoura, A.*, Sur les transformations moléculaires de l'hydrate chromique (pp. 1335-1338). *Tassilly*, Sur quelques combinaisons halogénées basiques des métaux alcalinoterreux (pp. 1338-1341). *Joly, A.*, et *Leidie, E.*, Action de la chaleur sur les azotites doubles alcalins des metaux du groupe du platine, composés de l'iridium (pp. 1341-1343). *Hallopeau, L. A.*, Sur les tungstates acides ammoniaco—sodiques (pp. 1343-1345). *Guye, Ph. A.*, et *Amaral, M. A. P.*, Pouvoirs rotatoires de quelques dérivés amyliques à l'état liquide et à l'état de vapeur (pp. 1345-1348. *Pickering, J. W.*, Sur les colloïdes de synthèse et la coagulation (pp. 1348-1351).

Tome cxx. No. 25. (24th June, 1895.)

*Bertheloto*, Nouvelles études sur la fluorescence de l'argon et sur sa combinaison avec les éléments de la benzine (pp. 1386-1390). *Berthelot* et *Rivals*, Sur les lactones ou olides campholéniques (pp. 1390-1392). *Berthelot*, Sur les chaleurs de dissolution et de neutralisation des acides campholéniques (pp. 1392-1393). *Moissan, H.*, Réduction de la silice par le charbon (pp. 1393-1394). *Friedel, C.*, Sur les produits de condensation de l'aldéhyde valérique (méthyl-2 butanal-4) ; observations relatives à la Note de MM. Barbier et Bouveault (p. 1394). *Manuvrier, G.*, Sur la détermination du rapport des deux chaleurs spécifiques de l'air (pp. 1398-1402). *Villard, P.*, et *Jarry, R*, Propriétés de l'acide carbonique solide (pp. 1413-1416). *Colson, A.*, Sur la formule de M. Guye (pp. 1416-1417). *Bouchardat* et *Tardy*, Sur les alcools dérivés d'un térébenthène droit, l'eucalyptène (pp. 1417-1740). *Barbier P.*, et *Bouveault, L.*, Condensation des aldéhydes non saturées de la série grasse avec la diméthylcétone ; synthèse d'hydrocarbures aromatiques (pp. 1420-1425). *Perrier, G.*, Combinaisons doubles des nitriles appartenant à la série grasse et à la série aromatique avec le chlorure d'aluminium (pp. 1423-1426).

Tome cxxi. No. 1. (1st July, 1895.)

*Haller, A*, Sur les produits d'oxydation du benzylidèncamphre et du benzyl-camphre. Nitrosate ou nitronitrite de benzylidènecamphre (pp. 35-39). *Hallopeau, L. A.*, Sur l'acide paratungstique (pp. 61-63). *Lasne, H.*, Sur le dosage de l'alumine dans les phosphates (pp. 63-66). *De Forcrand*, Sur l'amidure de sodium (pp. 66-69). *Cavalier, J.*, Sur les éthers phosphoriques de l'alcool allylique. Acide allylphosphorique (pp. 69-71). *Guinchant, J.*, Préparation de nouveaux éthers cyanométhiniques (pp. 71-74).

15e Année. Tome i. No 12. *Journal de Pharmacie et de Chimie.*
(15th Juin, 1895.)

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